Fisher Controls

Instruction Manual

2500 and 2503 Series Level-Trol® Controller/ Transmitters

FISHER®

July 1980 *Form 1013*

INTRODUCTION

Scope

This manual describes and provides installation, calibration, and startup instructions for 2500 and 2503 Series pneumatic controllers and transmitters used in combination with 249 Series and Type 259B displacer sensors. A typical controller-sensor combination is shown in figure 1. Complete maintenance instructions and parts lists are included for all the 2500 and 2503 Series controller/transmitters listed in the "Type Number Description" starting on this page.

Note

Although each of these controllers and transmitters is usually shipped with an attached supply pressure regulator and 249 Series or Type 259B sensor, this manual does not include regulator or sensor maintenance instructions and parts lists. For this information, refer to the instruction manuals for the appropriate regulator and either the 249 Series and Type 259B Caged Displacer Sensors or the 249 Series Cageless Displacer Sensors.

Read the remainder of the "Introduction" section and the "Principle of Operation" section on page 17 before performing any procedure. This will provide a means of becoming familiar with the function and location of various adjustment and alignment components.

Type Number Description

These instruments are designed to control or transmit liquid level, the level of interface between two liquids, or

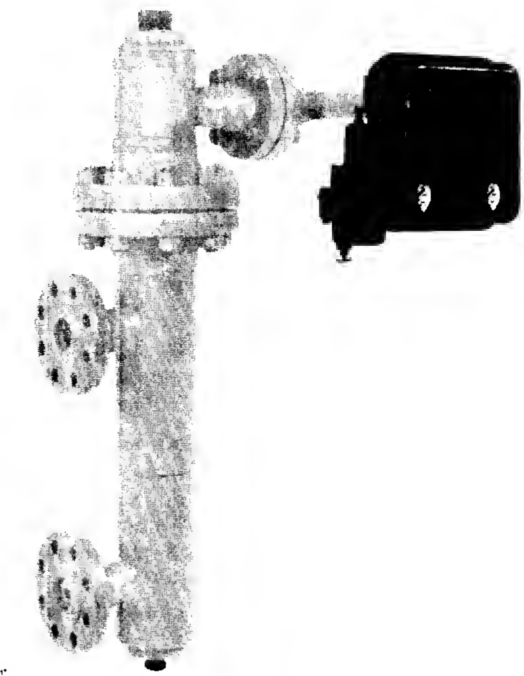


Figure 1. Type 2500 Controller on Caged 249 Series Sensor

density (specific gravity). Each unit consists of a 249 Series or Type 259B displacer-type liquid level sensor and a 2500 or 2503 Series pneumatic controller or transmitter. Controller/transmitter specifications are shown in table 1.

A change in liquid level, interface level, or density changes the buoyant force exerted on the sensor displacer, which in turn imparts a rotary motion to the torque tube shaft. The rotary motion is applied to the controller or transmitter, which uses a nozzle, bourdon tube, and pneumatic relay to convert the rotary motion to a standard pneumatic output signal. The output signal is sent to an indicating or final control element.

Table 1. Specifications

INPUT SIGNAL[1]	**Liquid Level or Liquid-to-Liquid Interface Level:** From 0 to 100 percent of displacer length—standard lengths for all sensors are ■ 14 inches or ■ 32 inches. Others available depending on construction **Liquid Density:** From 0 to 100 percent of displacement force change obtained with given displacer volume—standard volumes are ■ 60 inches^3 for Types 249C and 249CP sensors or ■ 100 inches^3 for Types 249C and 249CP sensors or ■ 100 inches^3 for most other sensors; others available depending on construction
OUTPUT SIGNAL[1]	**Type 2500 Controller and 2500T Transmitter:** ■ 3 to 15 psig (12 psig span) or ■ 6 to 30 psig (24 psig span) **Type 2500S and 2503 Controllers:** Zero (nominal) when off to full supply (■ 20 psig or ■ 35 psig nominal) when on
AREA RATIO OF RELAY DIAPHRAGMS	3:1
SUPPLY PRESSURE REQUIREMENT	■ 20 psig[2] for 3 to 15 or 0 to 20 psig output signal or ■ 35 psig[2] for 6 to 30 or 0 to 35 psig output signal
MAXIMUM SAFE SUPPLY PRESSURE	45 psig
SUPPLY PRESSURE CONSUMPTION	**Types with Proportional Valve** ***At 20 Psig:*** 4.2 scfh minimum[3], 27 scfh maximum[4] ***At 35 Psig:*** 7 scfh minimum[3], 42 scfh maximum[4] **Type 2503 Controller Without Proportional Valve:** Bleeds only when relay is exhausting
RECOMMENDED TYPE 2500 PROPORTIONAL BAND[1]	Full output pressure change adjustable over 10 to 100% of displacer length
TYPE 2500S OR 2503 DIFFERENTIAL GAP[1]	**Type 2500S Controller:** Full output pressure change adjustable over 20 to 100% of displacer length (recommended) **Type 2503 Controller:** Full output pressure change adjustable over approximately 25 to 40% of displacer length
RECOMMENDED TYPE 2500T SPAN[1]	Full output pressure change adjustable over 20 to 100% of displacer length
SET POINT[1] **(CONTROLLERS ONLY) OR ZERO ADJUSTMENT**[1] **(TRANSMITTERS ONLY)**	Continuously adjustable to position set point or differential gap of less than 100 percent on controllers or span of less than 100% on transmitters anywhere within the displacer length (liquid or interface level) or displacer force change (density)
PERFORMANCE	**Independent Linearity**[1] **(Transmitters Only):** 1 percent of output pressure change at span of 100 percent **Hysteresis:** 0.6 percent of output pressure change at 100 percent of proportional band, differential gap, or span **Repeatability**[1]**:** 0.2 percent of displacer length or displacement force change **Dead Band**[1] **(Except On-Off Controllers**[5]**):** 0.05 percent of proportional band or span **Typical Frequency Response**[1]**:** 4 Hz and 90-degree phase shift at 100 percent of proportional band, differential gap, or span with output piped to typical instrument bellows using 20 feet of 1/4 in. tubing **Ambient Temperature Error:** ±1.5 percent of output pressure change per 50°F of temperature change at 100 percent of proportional band, differential gap, or span when using sensor with standard wall Monel[6] torque tube **Reset**[1] **(Proportional-Plus-Reset Controllers Only):** Continuously adjustable from 0.005 to over 0.9 of a minute per repeat (from 200 to under 1.1 repeats per minute)
STANDARD TUBING CONNECTIONS	1/4 in. NPT female
MAXIMUM WORKING PRESSURES (SENSORS ONLY)	Consistent with applicable ANSI pressure/temperature ratings
OPERATIVE AMBIENT TEMPERATURES	See figure 2

1. Term defined in ISA Standard S51.1-1976.
2. Control and stability may be impaired if this pressure is exceeded.
3. At PROPORTIONAL BAND or SPECIFIC GRAVITY setting of 0 or 10.
4. At PROPORTIONAL BAND or SPECIFIC GRAVITY setting of 5.
5. Adjustable differential gap of on-off controllers is equivalent to an adjustable dead band.
6. Trademark of International Nickel Co.

Controllers and Transmitters

Standard 2500 and 2503 Series controller/transmitters come complete with supply and output pressure gauges and an integrally mounted Type 67FR regulator to reduce supply pressure from a maximum of 250 psig to the 20 or 35 psig required. This regulator has limited capacity relief and a standard 40-micron cellulose filter to remove particles from the supply source.

Type 2500*—Direct-acting, proportional, pneumatic controller with proportional valve.

Type 2500S*—Direct-acting, on-off, pneumatic controller with proportional valve.

Type 2500T*—Direct-acting, proportional, pneumatic transmitter with proportional valve.

Type 2503*—Direct-acting, on-off, pneumatic controller without proportional valve, for applications where very little snapping range adjustment is necessary.

Sensors (See Approprlate Sensor Instruction Manual for Complete Descriptions)

Types 249, 249B, 249C, 249K, 249L, 249N, and 259B—Sensors with displacer mounted in cage outside vessel.

Types 249BP, 249CP, 249P, and 249PT—Sensors mounted on top of vessel with displacer hanging down into vessel.

Types 249V and 249VT—Sensors mounted on side of vessel with displacer hanging out into vessel interior.

External sensors provide more stable operation than do internal sensors for vessels with internal obstructions or considerable internal turbulence.

Adjustments

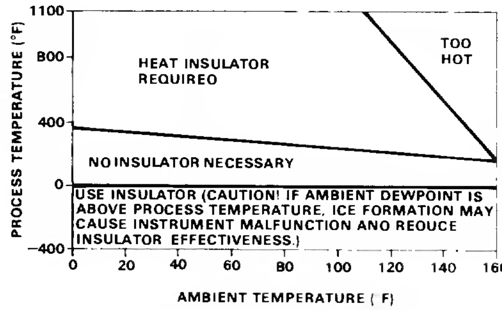
Controller/transmitter action description and adjustments are provided in this section. Refer to figure 3 for adjustment locations.

Controller/Transmitter Action Description

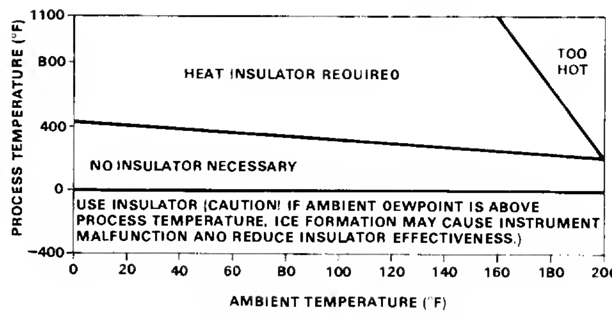
Note

The following descriptions apply only with right-hand mounting; left-hand mounting produces output signal behavior opposite that of the description.

*These products are also available in C and/or R variations. C versions have a pointer attached to the torque tube shaft that references displacer motion to an indicator base plate. R versions provide reverse rather than direct action.



STANDARD CONTROLLER OR TRANSMITTER



HIGH-TEMPERATURE CONTROLLER OR TRANSMITTER

Figure 2. Guidelines for Use of Optional Heat Insulator Assembly

Direct Action—Increasing liquid or interface level, or density, increases the output signal.

Reverse Action—Decreasing liquid or interface level, or density, increases the output signal. A factory-supplied reverse-acting unit has the suffix letter R added to the type number.

Level Set Adjustment (Controllers Only)

This adjustment is performed by opening the controller cover, loosening the knurled adjustment knob, and rotating the knob around the RAISE LEVEL dial in the upper right corner. Liquid or interface level is raised or density increased by rotating this knob in the same direction as the arrow points, while level is lowered or density decreased by rotating the knob opposite the direction of the arrow.

Zero Adjustment (Transmitters Only)

This adjustment is performed by opening the controller cover, using a screwdriver to loosen the slotted adjustment knob, and rotating the knob around the ZERO ADJUSTMENT dial in the upper right corner. This adjustment on a transmitter is used to set the output pressure so that it will correspond to a definite level on the displacer. Note that on a transmitter this adjustment is provided with a screwdriver slot to discourage tampering.

Proportional Band Adjustment (Except Transmitters and 2503 Series Controllers)

This adjustment is used to change the amount of displacement force change required to obtain full output pressure change. The adjustment is performed by opening the controller cover and turning the PROPORTIONAL BAND knob (just below the RAISE LEVEL dial). Refer to the introductory section of "Pre-Startup Checks" on page 10 for determining the proper setting.

Specific Gravity Adjustment (Transmitters Only)

Like the controller proportional band adjustment, this adjustment is used to change the amount of displacement force change required to obtain full output pressure change. The adjustment is performed by opening the transmitter cover and turing the SPECIFIC GRAVITY knob (just below the ZERO ADJUSTMENT dial). Refer to the introductory section of "Pre-Startup Checks" on page 10 for determining the proper setting.

INSTALLATION

The 2500 and 2503 Series controllers/transmitters are used in combination with 249 Series and Type 259B displacer type sensors, and unless ordered separately the controller or transmitter will be attached to the sensor.

WARNING

Personal injury or property damage due to sudden release of pressure, contact with hazardous fluid, fire, or explosion can be caused by puncturing, heating, or repairing a displacer that is retaining process pressure or fluid. This danger may not be readily apparent when disassembling the sensor or removing the displacer. Before disassembling the sensor or removing the displacer, observe the more specific warning provided in the sensor instruction manual.

Uncrating

Unless ordered separately, the controller or transmitter will be attached to the sensor when shipped. Carefully uncrate the assembly.

Note

Caged sensors have a rod and block installed on each end of the displacer to protect the displacer in shipping. These parts must be removed before sensor installation to release the displacer and allow it to function properly.

A caged sensor will be shipped with the displacer installed in the cage. If the sensor is ordered with a tubular gauge glass, the gauge glass will be crated separately and must be installed at the site. Be certain that the cage equalizing connections are not plugged with any foreign material. Caged constructions have a liquid damper with a hexagonal orifice installed in the lower equalizing connection. This damping orifice provides more stable operation, and it should not normally be removed. However, if the process liquid is such that it may clog the orifice with sediment, remove the damping plate. Pry the plate out with a screwdriver for flanged equalizing connections. Use a 1/2-inch hexagonal wrench to unscrew the plate from screwed equalizing connections.

A cageless sensor is shipped with the displacer separated from the sensor. A displacer longer than 32 inches is crated separately. A displacer 32 inches or under is crated with the sensor, but is not attached to the displacer rod. Inspect the displacer to be sure it was not dented in shipping. A dent may reduce the pressure rating of the displacer.

Controller/Transmitter Orientation

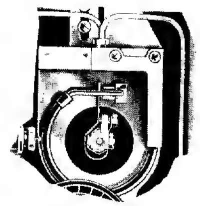
A controller/transmitter is to be mounted with the vent opening pointing downward as shown in figure 3 or 9. This orientation is necessary to ensure draining of accumulated moisture. The controller/transmitter is attached to the sensor in one or the other of the mounting positions shown in figure 4: right hand (with the case to the right of the displacer when looking at the front of the case) or left hand (with the case to the left of the displacer). The mounting position can be changed in the field if required; refer to the appropriate sensor manual for instructions. Changing this mounting position will change controller action from direct to reverse, or vice versa.

All caged sensors except the Type 259B have a rotatable head. That is, the controller/transmitter may be positioned at any of eight alternate positions around the cage as indicated by the numbers 1 through 8 in figure 4. To rotate the head, remove the head flange bolts and nuts and position the head as desired.

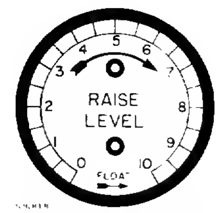
Mounting Caged Sensor

CAUTION

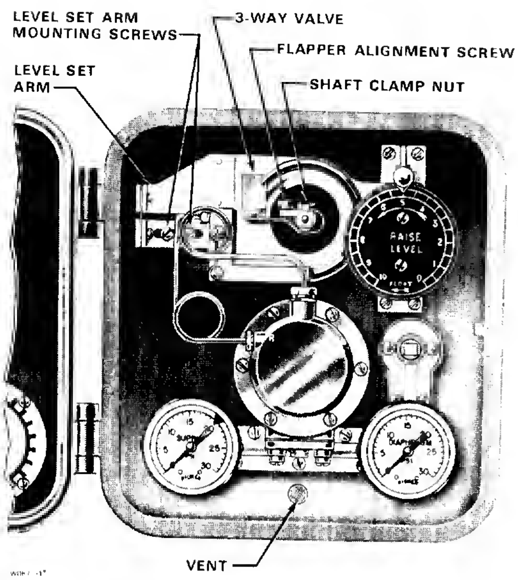
The cage must be plumb when installed so that the displacer will not touch the cage wall. If the displacer touches the cage wall while the unit is in service, the unit will transmit an erroneous output signal.



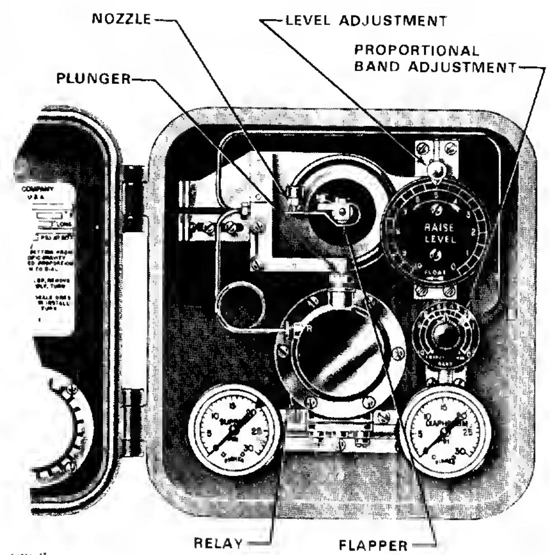
BOURDON TUBE DETAIL OF TYPE 2500S ON-OFF CONTROLLER



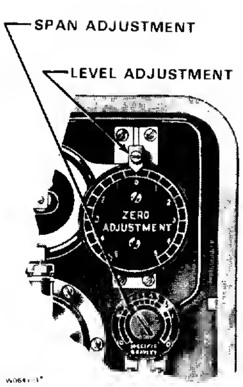
RAISE LEVEL DIAL FOR LEFT-HAND MOUNTING



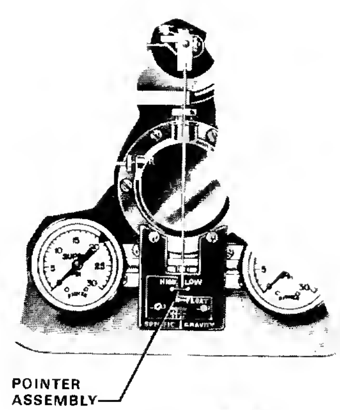
RIGHT-HAND MOUNTED TYPE 2503R ON-OFF CONTROLLER



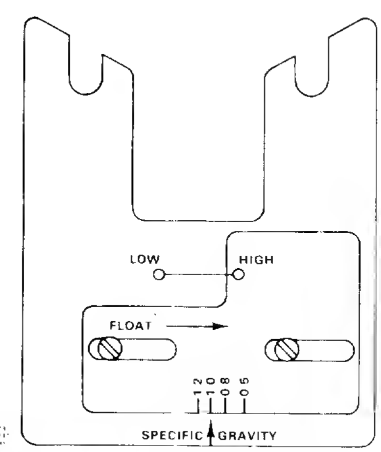
RIGHT-HAND MOUNTED TYPE 2500 PROPORTIONAL CONTROLLER



DETAIL OF TRANSMITTER ADJUSTMENTS



INDICATOR ASSEMBLY WITH RIGHT-HAND MOUNTING



TRAVEL INDICATOR PLATE FOR LEFT-HAND MOUNTING

Figure 3. Adjustment Locations

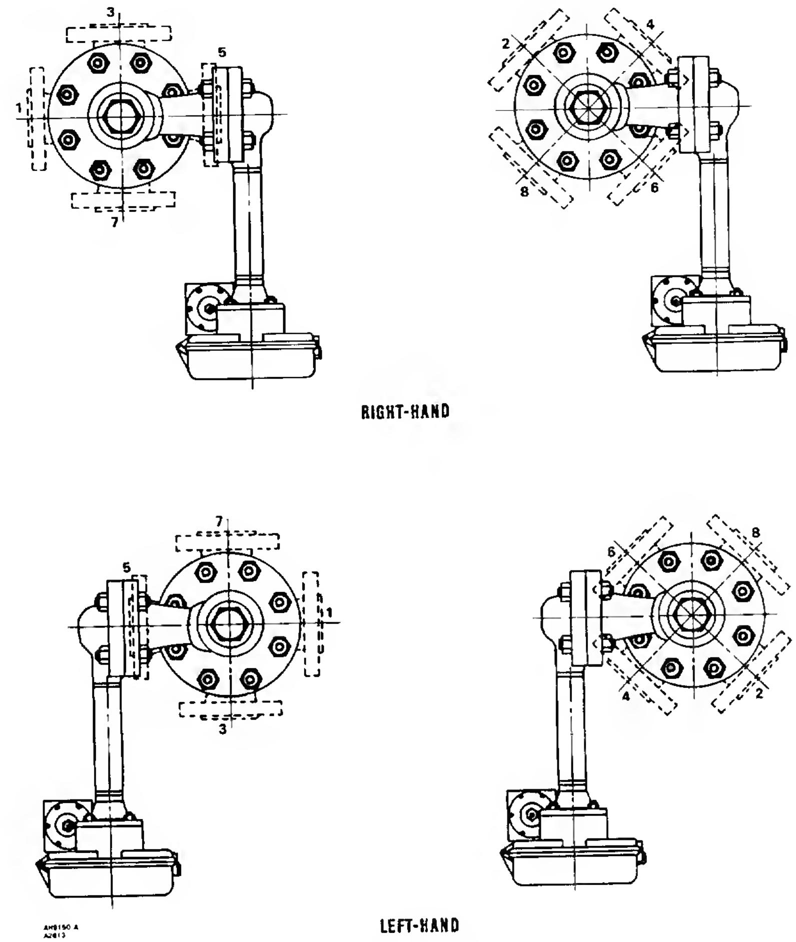


Figure 4. Cage Head Mounting Positions

Note

If the controller/transmitter is not mounted on the sensor, refer to the "Mating Controller/ Transmitter to Sensor" section on page 22. That section also provides instructions for adding a heat insulator to a unit.

If the displacer is equipped with a temperature-compensated displacer or piezometer ring, refer to the Special Constructions section on page 9 before proceeding.

Cage connections will normally be either 1-1/2 or 2-inch screwed or flanged and may be ordered in the combinations shown in figure 5. A shutoff or hand valve with a 1-1/2-inch diameter or larger port is recommended in each of the equalizing lines. A drain—between the cage and shutoff or hand valve—is recommended whenever the bottom cage line will have a liquid-trapping low point.

Mount the cage by running equalizing lines between the cage connections and the vessel (see figure 6). On liquid or interface level applications, position the sensor so that the line marked FLOAT CENTER on the cage is located as close as possible to the center of the liquid level or interface level range being measured.

For liquid or interface level applications, it is advantageous to install a gauge glass either on the vessel, or on the sensor cage if the cage is so tapped.

Mounting Cageless Sensor

CAUTION

If a stillwell is used, it must be plumb when installed so that the displacer will not touch the wall of the stillwell. If the displacer touches the wall while the unit is in service, the unit will transmit an erroneous output signal.

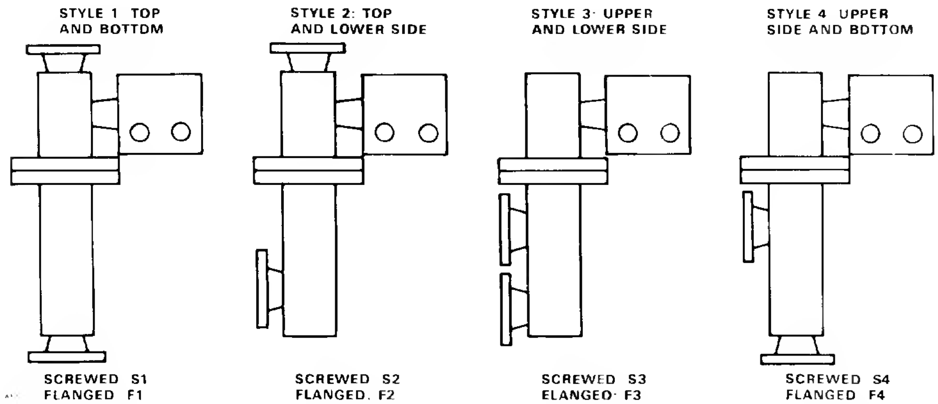


Figure 5. Cage Connection Styles

Since the displacer hangs inside the vessel, it is advisable to provide a stillwell around the displacer when the liquid is in a state of continuous agitation and excessive turbulence can be expected.

CAUTION

Since a displacer used in an interface level or a density application always must be completely submerged during operation, obtaining desired controller or transmitter sensitivity requires the use of either a thin-wall torque tube or an overweight displacer, or both. An overweight displacer cannot be used for any service except those conditions for which it was specified. A thin-wall torque tube has a "T" stamped on the face of the sensor end flange (not visible unless the controller/transmitter is taken off according to the "Removing Controller/Transmitter from Sensor" section on page 21). Since use of such a torque tube and/or displacer with a cageless sensor increases the possibility of overstressing the torque tube under dry conditions, this type of sensor construction has a travel stop provided when necessary to keep from damaging the torque tube. Be sure to avoid damaging such a sensor construction by using care in installation and by always supporting the displacer if the travel stop must be removed. See the Cageless 249 Series Displacer Sensors instruction manual for Type 249V travel stop plate locations.

Note

If the controller/transmitter is not mounted on the sensor, refer to the "Mating Controller/Transmitter to Sensor" section on page 22.

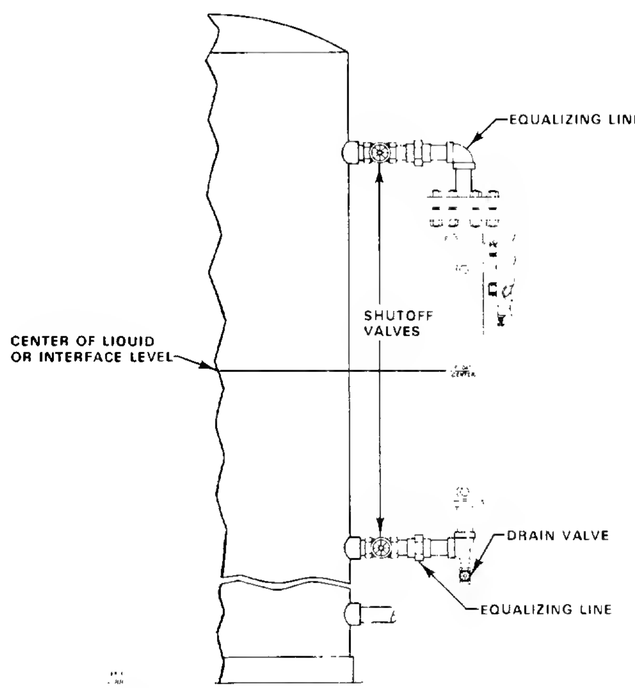


Figure 6. Caged Sensor Mounting

That section also provides instructions for adding a heat insulator to a unit. If the sensor is equipped with a temperature-compensated displacer or piezometer ring, refer to the "Special Constructions" section on page 9 before proceeding.

A cageless sensor is to be attached to a flanged connection on the vessel as shown in figure 7. For interface or liquid level applications, install a gauge glass on the vessel.

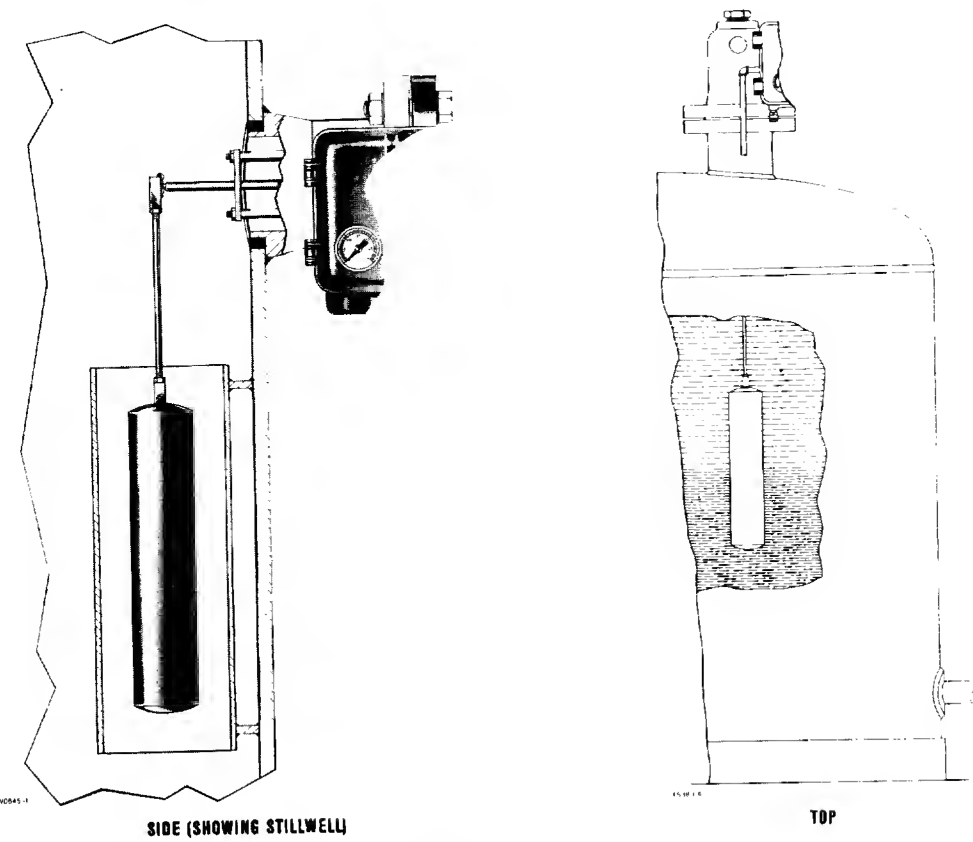


Figure 7. Cageless Sensor Mounting

CAUTION

If the displacer is to be inserted into the vessel before being attached to the displacer rod, provide a suitable means of supporting the displacer to prevent it from dropping into the vessel and suffering damage.

To help support a Type 249BP, 249CP, 249P, or 249PT displacer, install the displacer stem and stem end piece, or a threaded rod, into the 1/4"-28 UNF threaded hole in the displacer spud or stem end piece (figure 8). On the types 249BP and 249P with travel stop, the stem end piece pins will secure the displacer as long as the travel stop plate is installed and the sensor head is in position.

Side-Mounted Sensor

If a stillwell is required, the displacer must be attached to the displacer rod from inside the vessel. Connect the displacer as shown in figure 8, locking the assembly with the cotter spring provided. If a stillwell is not required, the displacer can be attached to the displacer rod before mounting the sensor to the vessel connection. The displacer may then be swung out horizontally for insertion into the vessel. If an extension is used between the displacer spud and the displacer stem end piece, make sure the nuts are tight at each end of the displacer stem extension. Install and tighten suitable bolting or cap screws in the flanged connection to complete the installation.

Top-Mounted Sensor

The displacer may be attached to the displacer rod before installing the sensor on the vessel. Where the displacer diameter is small enough, it may be desirable to install a long or sectionalized displacer through the sensor head access hole after the sensor is installed on the vessel. Connect the displacer as shown in figure 8, locking the assembly with the cotter springs provided. If a stem is used between the displacer spud and the stem end piece, make sure the nuts are tight at each end of the stem. Install and tighten suitable cap screws in the flanged connection to complete the installation.

Supply Pressure Connections and Requirements

The output pressure connection is on the back of the controller/transmitter case (figure 9). Pipe the supply pressure to the IN connection of the regulator mounted to the case back. Provide a clean, dry, and noncorrosive air or gas supply to the controller/transmitter as follows:

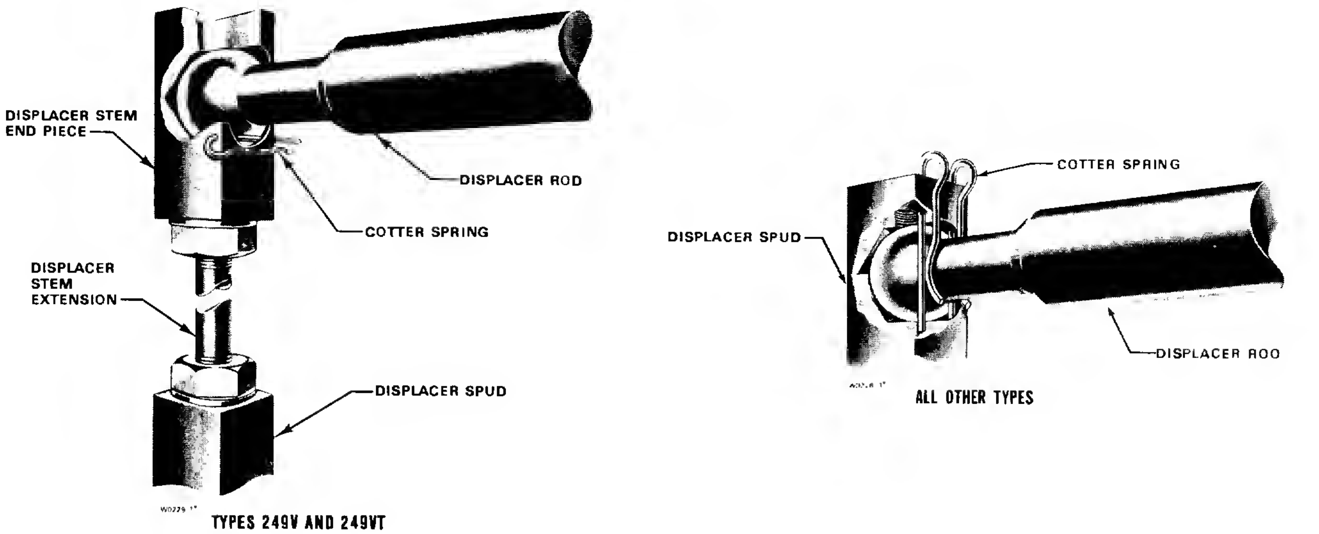


Figure 8. Displacer-Displacer Rod Connections

Output Signal Range	Recommended Supply Pressure
3 to 15 or 0 to 20 psig 6 to 30 or 0 to 35 psig	20 psig 35 psig

WARNING

As the controller or transmitter is capable of providing full supply pressure to connected equipment, supply pressure must never exceed the maximum safe working pressure of any connected equipment or of the controller/transmitter. If the supply pressure source is capable of exceeding any of these maximum safe working pressures, appropriate steps must be taken during installation to protect the controller or transmitter and connected equipment against accidental overpressure. Failure to provide such protection may result in equipment damage and personal injury.

After pressure connections have been made, turn on the supply pressure and check all connections for leaks.

Special Constructions

Temperature-Compensated Displacer

Some sensors use a temperature-compensated displacer (figure 10). This displacer is used in density applications where the effects of temperature changes on the specific gravity value cannot be tolerated. The displacer must be filled with the liquid to be measured, or with a liquid of

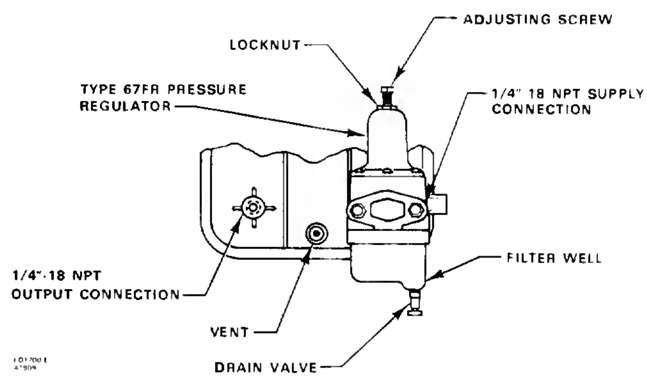


Figure 9. Pressure Connections

equal expansion coefficient. In service, the displacer expands and contracts the same amount as the measured liquid to nullify signal changes that would be caused by temperature changes.

This type of displacer is shipped in a separate carton but crated with the rest of the assembly. See the appropriate sensor manual for filling instructions.

Piezometer Ring

Some sensors use a piezometer ring (figure 11) to reduce velocity effects caused by liquid passing through the displacer cage when it is desired to measure the specific gravity of a liquid in a flowing line, and when the fluid velocity exceeds two feet per minute past the displacer in the cage. To install this type of sensor, connect a line to the cage inlet and outlet piping at each end of the cage. Hand valves should be used to balance the liquid flow through the cage and keep the displacer cage filled. It is advisable to

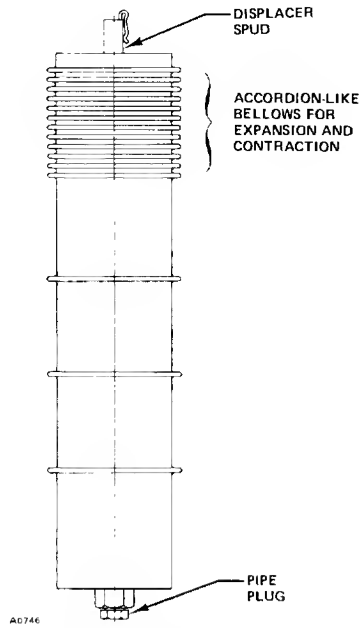


Figure 10. Temperature-Compensated Displacer

provide a rotameter or sight flow fitting for measuring velocity through the cage. If the flow rates are properly balanced by the hand valves, the transmitter output will show little change when flow to the cage is shut off. If the total flow rate through the cage is too high (rate of sampling too great), turbulence may cause a somewhat erratic output signal whether or not the two output flows are balanced properly.

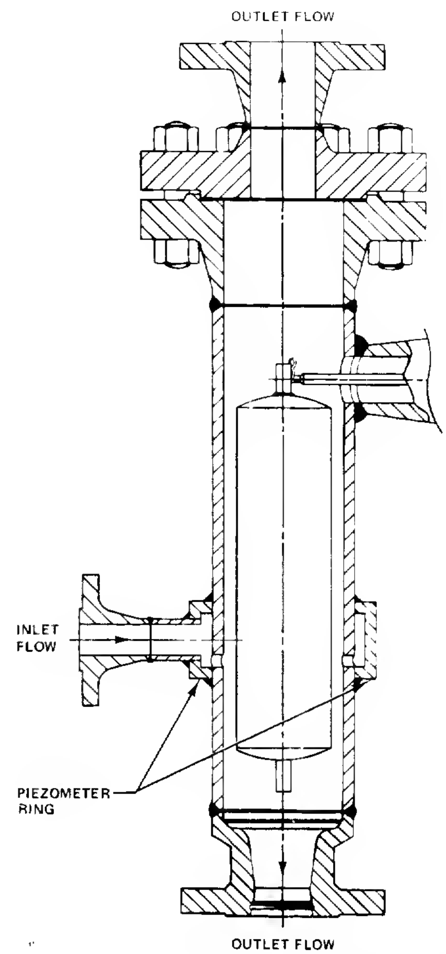


Figure 11. Piezometer-Ring Cage for Flow Line Mounting

PRE-STARTUP CHECKS

Adjustment locations are shown in figure 3 unless otherwise indicated. When performing the checks, open loop conditions must exist. One way to obtain an open loop is to ensure that there is no flow through the final control element. Another way to obtain an open loop is to disconnect the controller/transmitter output signal line and plug the output connection.

If the process variable cannot be varied sufficiently, follow the instructions in the"Precalibration Requirements" section on pages 14 and 15 as necessary to simulate the process variable changes required for these checks.

Make sure that the RAISE LEVEL dial on a controller is mounted with the correct side facing out. If the displacer is to the left of the controller, use the side on which the arrow at the bottom of the dial points to the left; if the displacer is to the right of the controller, the arrow should point to the right. The level directions shown on the dial will be correct for both direct-acting and reverse-acting controllers. A transmitter ZERO ADJUSTMENT dial uses the same side for both right-and left-hand displacer mounting.

On a controller or transmitter with mechanical indicator assembly, the travel indicator plate is marked on both sides. If the displacer is to the left of the controller or transmitter, the side of the plate that has the arrow pointing to the left should be used. If the displacer is to the right of the controller or transmitter, use the side of the plate that has the arrow pointing to the right.

Set the PROPORTIONAL BAND control on a Type 2500 or 2500S controller, or the SPECIFIC GRAVITY control on a Type 2500T transmitter, as follows:

- **Sensor with Both Standard Torque Tube and Displacer of Recommended Volume**—If the torque tube is standard and displacer volume is close to that recommended in table 2, use figure 12 to find the PROPORTIONAL BAND or SPECIFIC GRAVITY setting. Take the specific gravity of

the process liquid on liquid level applications, or the difference between minimum and maximum specific gravity on interface level or density applications, and locate this value on the vertical axis of the chart. From this location, trace horizontally to the curve with the desired proportional band, differential gap, or span percentage, and then trace vertically down to determine the proper dial setting on the horizontal axis.

- **Sensor with Nonstandard Torque Tube and/or Displacer with Other than Recommended Volume**—If the construction has either or both a nonstandard torque tube and a displacer volume that deviates significantly from the recommended table 2 value, the PROPORTIONAL BAND or SPECIFIC GRAVITY dial setting will not indicate the actual proportional band, differential gap, or span of the unit. Therefore, a corrected dial setting must be used. To determine the required dial setting, solve the equation:

$$\text{Corrected Dial Setting Required} = (PB)\,(SP\ GR)\left(\frac{V_a}{V_r}\right)(X)$$

where,

PB = desired proportional band or differential gap of controller or span of transmitter, in percent of total input span desired to yield full output signal change of controller or transmitter

SP GR = specific gravity of the process liquid (for interface level control, use the difference between the specific gravity of the two liquids; for specific gravity control, use the difference between the upper and lower range limits of specific gravity)

V_a = actual displacer volume, cubic inches (may be found on unit nameplate or serial card in your shop)

V_r = recommended displacer volume, cubic inches (see table 2)

X = torque tube factor (1.0 for standard torque tubes, 2.0 for thin-wall torque tubes, or 0.5 for heavy-wall torque tubes)

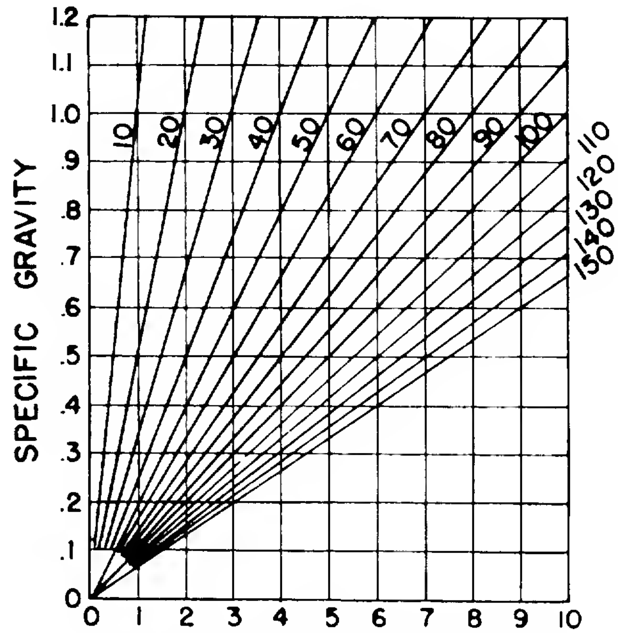


Figure 12. Proportional Band, Differential Gap, or Span Setting Chart

Table 2. Recommended Displacer Volumes

Sensor Type	Recommended Volume (Cubic Inches)
249, 249B, 249BP, 249K, 249N, 249P through Class 600, 259B	100
249C, 249CP, 249PT, 249VT	60
249L, 249P over Class 600	120
249V	85*

*With standard 12-inch flange-face-to-displacer centerline dimension only

Type 2500 Controller or 2500T Transmitter

1. Turn on the supply pressure and check that the SUPPLY gauge reads 20 psig for a 3 to 15 psig or 35 psig for a 6 to 30 psig output pressure range. If necessary to adjust the Type 67FR regulator, loosen the locknut (figure 9) and turn the adjusting screw clockwise to increase or counterclockwise to decrease pressure. Be sure to tighten the locknut after setting the pressure.

2. Locate the process variable at its minimum value. (That is, lower the liquid below the displacer on liquid level applications, place the interface at the bottom of the displacer on interface level applications, or set the specific gravity at the minimum on density applications.)

3. Make sure that the PROPORTIONAL BAND or SPECIFIC GRAVITY control is at the setting determined earlier in this section. Then set the RAISE LEVEL or ZERO ADJUSTMENT control at an appropriate value according to table 3. This table gives recommended RAISE LEVEL and ZERO ADJUSMENT settings based on maximum and minimum possible PROPORTIONAL BAND and SPECIFIC GRAVITY settings. If an intermediate PROPORTIONAL BAND or SPECIFIC GRAVITY setting has been determined to be necessary, use an appropriate RAISE LEVEL or ZERO ADJUSTMENT setting that is in between the ones given in table 3.

4. Check that the OUTPUT gauge on a 3 to 15 psig range reads 3 psig for direct or 15 psig for reverse action, or on a 6 to 30 psig range reads 6 psig for direct or 30 psig for reverse

Table 3. Recommended Settings for Pre-Startup Checks

MOUNTING	ACTION	RECOMMENDED *RAISE LEVEL* SETTING FOR TYPE 2500 CONTROLLER		RECOMMENDED *ZERO ADJUSTMENT* SETTING FOR TYPE 2500T TRANSMITTER	
		For Predetermined PROPORTIONAL BAND Setting of 10	For Predetermined PROPORTIONAL BAND Setting of 0	For Predetermined SPECIFIC GRAVITY Seting of 1.0	For Predetermined SPECIFIC GRAVITY Setting of 0
Right-Hand	Direct Reverse	3.0 to 3.5 6.5 to 7.0	4.0 to 4.5 0.5 to 1.0	1.5 to 2.0 to right 1.5 to 2.0 to left	0.5 to 1.0 to right 4.0 to 4.5 to right
Left-Hand	Direct Reverse	3.0 to 3.5 6.5 to 7.0	4.0 to 4.5 0.5 to 1.0	1.5 to 2.0 to left 1.5 to 2.0 to right	0.5 to 1.0 to left 4.0 to 4.5 to left

action. On a controller or transmitter with mechanical indicator assembly, the pointer should be over the LOW point on the indicator plate; slight adjustment might be necessary by loosening the side hex clamp nut (key 40, figure 17), shifting the pointer, and retightening the nut.

5. Now increase the process variable by the desired amount that will produce full output pressure change. Check that the OUTPUT gauge on a 3 to 15 psig range reads 15 psig for direct or 3 psig for reverse action, or on a 6 to 30 psig range reads 30 psig for direct or 6 psig for reverse action. On a controller or transmitter with indicator assembly, the pointer should be over the HIGH point on the indicator plate; slight plate adjustment might be necessary as described at the end of step 4.

6. Perform the "Calibrating Procedure" on page 15 if controller or transmitter changes disagree with those given in steps 4 and 5. If all pre-startup checks are satisfactory, however, proceed to the "Startup" section on page 16.

Type 2500S Controller

1. Turn on the supply pressure and check that the SUPPLY gauge reads 20 psig for a 0 to 20 psig or 35 psig for a 0 to 35 psig output pressure range. If necessary to adjust the Type 67FR regulator, loosen the locknut (figure 9) and turn the adjusting screw clockwise to increase or counter-clockwise to decrease pressure. Be sure to tighten the locknut after setting the pressure.

2. Locate the process variable at its minimum value. (That is, lower the liquid below the displacer on liquid level applications, place the interface at the bottom of the displacer on interface level applications, or set the specific gravity at the minimum on density applications.) On a controller with mechanical indicator assembly, the pointer should be over the LOW point on the indicator plate; slight adjustment might be necessary by loosening the side hex clamp nut (key 40, figure 17), shifting the pointer and retightening the nut.

Note

Adjustment of the RAISE LEVEL control can set the switching points anywhere within the length of the displacer. When setting these points, be careful not to set them so that one is off the displacer.

3. Make sure that the PROPORTIONAL BAND control is at the setting determined according to pages 10 and 11. Zero the RAISE LEVEL control and then set it to 1.0 for a direct-acting or 4.0 for a reverse-acting controller.

4. Check that the OUTPUT gauge reads 0 psig for direct or either 20 or 35 psig for reverse action.

5. Now increase the process variable to the desired switching point at which the OUTPUT gauge is to read either 20 or 35 psig for direct or 0 psig for reverse action. On a controller with indicator assembly, the pointer should be over the HIGH point on the indicator plate; slight plate adjustment might be necessary as described at the end of step 2.

6. Readjust the RAISE LEVEL control until the OUTPUT gauge again reads 0 psig for direct or either 20 or 35 psig for reverse action. Then adjust the RAISE LEVEL control to the point where the OUTPUT gauge reads either 20 or 35 psig for direct or 0 psig for reverse action.

7. Decrease the process variable to the desired switching point at which the OUTPUT gauge is to read 0 psig for direct or either 20 or 35 psig for reverse action.

8. Recheck both switching points, and adjust as necessary, as follows:

- For direct-acting controllers, the controller output signal will switch from zero pressure to full supply pressure when an increasing process variable passes the upper switching point. The output signal will not return to zero pressure until a decreasing process variable passes the lower switching point. Adjusting the RAISE LEVEL control will move both switching points equally in the direction of adjustment. Adjusting the PROPORTIONAL BAND control will widen or narrow the differential gap between the two switching points by moving the position of the lower switching points.

- For reverse-acting controllers, the controller output signal will switch from zero pressure to full supply pressure

when a decreasing process variable passes the lower switching point. The output signal will not return to zero pressure until an increasing process variable passes the upper switching point. Adjusting the RAISE LEVEL control will move both switching points equally in the direction of adjustment. Adjusting the PROPORTIONAL BAND control will widen or narrow the differential gap between the two switching points by moving the position of the upper switching point.

9. Perform the "Calibrating Procedure" on page 15 if controller output pressure cannot be made to shift from zero to full supply pressure and back at the desired switching points. If all pre-startup checks are satisfactory, however, proceed to the "Startup" section of page 16.

Type 2503 Controller

Note

Since the Type 2503 controller has no proportional valve, the differential gap between switching points is adjusted by varying the supply pressure. This gap can be varied from approximately 3.5 inches level change at 15 psig to 6.0 inches level change at 25 psig when the fluid has a specific gravity of 1.0 and the displacer is of 100 cubic inches displacememt. The gap also varies inversely according to density; a fluid with 0.8 specific gravity produces 4.4 inches level change at 15 psig to 7.5 inches change at 25 psig. Be sure to set the gap at a pressure low enough to be compatible with the limitations of the diaphragm control valve or other final control element.

1. Turn on the supply pressure. If necessary to adjust the Type 67FR regulator to produce the desired differential gap, loosen the locknut (figure 9) and turn the adjusting screw clockwise to increase or counterclockwise to decrease pressure. Be sure to tighten the locknut after setting the pressure.

2. Locate the process variable at its minimum value. (That is, lower the liquid below the displacer on liquid level applications, place the interface at the bottom of the displacer on interface level applications, or set the specific gravity at the minimum on density applications.)

Note

Adjustment of the RAISE LEVEL control can set the switching points anywhere within the length of the displacer. When setting these points, be careful not to set them so that one is off the displacer.

3. Zero the RAISE LEVEL control and then reset it as follows:

- **Direct-Acting Controller**—Between 1.0 and 1.5.
- **Reverse-Acting Controller**—Between 3.5 and 4.0.

4. Check that the OUTPUT gauge reads 0 psig for direct or either 20 or 35 psig for reverse action.

5. Now increase the process variable to the desired switching point at which the OUTPUT gauge is to read either 20 or 35 psig for direct or 0 psig for reverse action.

6. Readjust the RAISE LEVEL control until the OUTPUT gauge again reads 0 psig for direct or either 20 or 35 psig for reverse action. Then adjust the RAISE LEVEL control to the point where the OUTPUT gauge reads either 20 or 35 psig for direct or 0 psig for reverse action.

7. Decrease the process variable to the desired switching point at which the OUTPUT gauge is to read 0 psig for direct or either 20 or 35 psig for reverse action.

8. Recheck both switching points, and adjust as necessary, as follows:

- For direct-acting controllers, the controller output signal will switch from zero pressure to full supply pressure when an increasing process variable passes the upper switching point. The output signal will not return to zero pressure until a decreasing process variable passes the lower switching point. Adjusting the RAISE LEVEL control will move both switching points equally in the direction of adjustment. Varying the supply pressure will widen or narrow the differential gap between the two switching points by moving the position of the lower switching point.

- For reverse-acting controllers, the controller output signal will switch from zero pressure to full supply pressure when a decreasing process variable passes the lower switching point. The output signal will not return to zero pressure until an increasing process variable passes the upper switching point. Adjusting the RAISE LEVEL control will move both switching points equally in the direction of adjustment. Varying the supply pressure will widen or narrow the differential gap between the two switching points by moving the position of the upper switching point.

9. Perform the "Calibrating Procedure" on page 15 if controller output pressure cannot be made to shift from zero to full supply pressure and back at the desired switching points. If all pre-startup checks are satisfactory, however, proceed to the "Startup" section on page 16.

CALIBRATION

Precalibration Requirements

Note

Calibration of a unit with a thin wall torque tube will have to be conducted with the displacer completely submerged in a liquid of the specific gravity for which the unit was designed.

To perform the "Calibrating Procedure" on page 15, it will be necessary to put the controller or transmitter into operation. This may be done either on the vessel with the actual service liquid or in the shop where other means of obtaining a displacement force change must be provided. It must be done in the shop if the process variable is not available for calibration or if the process cannot be varied for calibration. There are two methods of adapting the "Calibrating Procedure" to shop calibration.

Wet Calibration

Remove the entire controller/transmitter and sensor assembly from the vessel. To simulate actual process input conditions in the shop, suspend the displacer to appropriate depths in a liquid having a specific gravity equal to that of the process liquid. For caged sensors, the liquid used may be poured into the cage. If necessary, water may be used for wet calibration in the shop. However, compensation must be made for the difference between the specific gravity of the water and that of the process liquid. For example, assume that the process liquid has a specific gravity of 0.7 and that wet calibration with water (specific gravity of 1.0) is desired. To simulate a process level of 50% of the input span, a water level of 35% is required (0.7/1.0 x 50% = 35%).

Dry Calibration

Remove the controller/transmitter and torque tube arm, as a single unit, from the cage or vessel. Then, wherever the standard calibration instructions in this manual require a specific process variable for input to the sensor, simulate that variable by suspending the proper weight (such as a can of sand) from the end of the displacer rod. Complete the "Removing Controller/Transmitter and Torque Tube Arm" and "Determining Amount of Suspended Weight" sections below before proceeding to the "Calibrating Procedure."

Removing Controller/Transmitter and Torque Tube Arm

WARNING

To avoid personal injury from contact with the process liquid, lower the vessel level below the sensor torque tube arm or shut off the cage equalizing valves and drain the cage before proceeding. For closed vessels, release any pressure that may be above the liquid.

When removing the displacer from the displacer rod or removing the controller/transmitter and torque tube arm from the cage or vessel, refer to the appropriate 249 Series and/or Type 259B instruction manual for assistance. The method of removing the displacer or torque tube arm and attached controller or transmitter will vary with the type of sensor.

For a caged sensor with top equalizing connection, it may be desired to remove the entire cage from the vessel before disassembling.

CAUTION

If the displacer is to be disconnected from the displacer rod before the sensor is removed from the cage or vessel, provide a means of supporting the displacer to prevent it from dropping and suffering damage. The spuds or stem end pieces on all displacers have holes suitable for rods or other supports. Additionally, the displacer stem and stem end piece, or a threaded rod may be installed into the 1/4"-28 UNF threaded hole in the displacer spud or stem end piece of top-mounted cageless and all caged sensors. For some top-mounted sensors with long displacers, it may also be possible to remove the sensor through the access hole in the sensor head. On the types 249BP and 249P with travel stop, the stem end piece pins will secure the displacer as long as the travel stop plate is installed and the sensor head is in position.

Determining Amount of Suspended Weight

CAUTION

To avoid overloading a torque tube sized for interface or density applications under dry conditions, consult your Fisher representative for the maximum allowable substitute weight W_s that may be used with your particular construction.

To determine the total weight that must be suspended from the displacer rod to simulate a certain condition of liquid level or specific gravity, solve the equation:

$$W_s = W_d - [(0.0361)\ (V)\ (SP\ GR)]$$

where,

W_s = total suspended weight, pounds (should never be less than 0.5 pound; for a unit with a horizontal displacer, make sure the center of gravity of the substitute weight is where it would be on the actual displacer).

Note

To simulate the lower range limit of the input span for liquid level control only, it is necessary to suspend only the displacer from the displacer rod. For other values of input span, remove the displacer and suspend a weight as determined in the equation above.

W_d = weight of displacer, pounds (determine by weighing displacer)

0.0361 = weight of one cubic inch of water (specific gravity = 1.0), pounds

V = volume of displacer that would be submerged at level required by calibration procedure, cubic inches:
$V = \pi/4$ (displacer diameter)^2 x (length of displacer submerged)

SP GR = specific gravity of process liquid at operating temperature

For interface level measurement, the equation becomes:

$$W_s = W_d - [(0.0361)\ (V_l)\ (SP\ GR_l) + (0.0361)\ (V_h)\ (SP\ GR_h)]$$

where,

V_l = volume of displacer submerged by the lighter liquid, cubic inches:
$V = \pi/4$ (displacer diameter)^2 x (length of displacer submerged)

$SP\ GR_l$ = specific gravity of lighter liquid at operating temperature

V_h = volume of displacer submerged by heavier liquid, cubic inches:
$V = \pi/4$ (displacer diameter)^2 x (length of displacer submerged)

$SP\ GR_h$ = specific gravity of heavier liquid at operating temperature

Calibrating Procedure

Adjustment locations are shown in figure 3 unless otherwise indicated. When calibrating, open loop conditions must exist. One way to obtain an open loop is to ensure that there is no flow through the final control element. Another way to obtain an open loop is to disconnect the controller/ transmitter output signal line and plug the output connection.

Several steps in these calibrating procedures require setting the process variable at the minimum and maximum limits of the input span, as follows:

Liquid Level Applications

- **Minimum**—Displacer to be completely out of liquid.
- **Maximum**—Displacer to be completely submerged in liquid.

Interface Level Applications

- **Minimum**—Displacer to be completely submerged in lighter of two process liquids.
- **Maximum**—Displacer to be completely submerged in heavier of two process liquids.

Density Applications

- **Minimum**—Displacer to be completely submerged in liquid having lowest specific gravity of range.
- **Maximum**—Displacer to be completely submerged in liquid having highest specific gravity of range.

Note

If the process cannot be varied readily or the "Wet Calibration" method cannot be used in the following steps, be sure to use the proper sequence of correct weights as found in "Determining Amount of Suspended Weight." Whenever the following steps require particular "Pre-Startup Checks" procedures, refer as appropriate to the "Type 2500 Controller or 2500T Transmitter" section on page 11, the "Type 2500S Controller" section on page 12, or the "Type 2503 Controller" section on page 13.

1. Turn on the supply pressure and check that it is set according to the appropriate "Pre-Startup Checks" section.

2. Locate the process variable at the minimum limit of the input span according to the limitations given above. Additionally, make sure that the pointer on constructions with an indicator assembly is over the LOW point.

3. Make sure that the PROPORTIONAL BAND or SPECIFIC GRAVITY control (except on a Type 2503

controller) is at the setting determined according to the appropriate "Pre-Startup Checks" section.

4. If impossible to obtain the correct initial output pressure according to the appropriate "Pre-Startup Checks" section, adjust the RAISE LEVEL or ZERO ADJUSTMENT control until the OUTPUT gauge reads as follows:

- 3 psig (3 to 15 psig range) or 6 psig (6 to 30 psig range) for direct-acting Type 2500 controller or Type 2500T transmitter.

- 15 psig (3 to 15 psig range) or 30 psig (6 to 30 psig range) for reverse-acting Type 2500 controller or Type 2500T transmitter.

- 0 psig for direct-acting Type 2500S or 2503 controller.

- 20 psig (0 to 20 psig range) or 35 psig (0 to 35 psig range) for reverse-acting Type 2500S or 2503 controller.

Note

In the following step, the alignment screw (key 33, figure 17 or 18) always should be screwed in far enough to provide tension on the flapper.

5. Make sure that the flapper is centered over the nozzle by loosening the hex clamp nut (key 40, figure 17 or 18), sliding the flapper in or out, and tightening the nut. Then adjust the alignment screw in or out as follows:

- **Type 2500 Controller or 2500T Transmitter**—Until the flapper is perpendicular to the nozzle tip.

- **Type 2500S or 2503 Controller**—To just snap the output pressure to either 20 or 35 psig.

6. Relocate the process variable at the maximum limit of the input span according to page 15. See if the OUTPUT gauge change is different from the normal proportional span of 12 or 24 psig or snapping span of 20 or 35 psig.

Note

Any sliding of the level set arm (key 28, figure 17 or 18) in the following step will change the zero as well as the output pressure span.

7. If controller or transmitter changes disagree with those given in step 6, correct the span by loosening the two level set arm mounting screws, sliding the level set arm back and forth along the elongated slot, and retightening the screws. Sliding the level set arm to the left increases the output pressure span. Sliding the level set arm to the right decreases the span. To change pointer span, loosen the indicator plate screws (key 41, figure 17), slide the plate until the LOW or HIGH point is under the pointer as desired, and tighten the plate screws.

8. Repeat steps 1 through 7 until the required output pressure and pointer spans are obtained.

9. Rezero the RAISE LEVEL or ZERO ADJUSTMENT control as required. On a direct-acting Type 2500S or 2503 controller, readjust the RAISE LEVEL control until it will just snap the output pressure back to 0 psig. This will ensure that the lower switching point will be somewhere close to the bottom of the displacer.

Note

If you find that the controller or transmitter cannot be calibrated, look for other troubles as described in the "Troubleshooting" section on page 19, such as a nonperpendicular flapper-nozzle condition, leaky connections, or a binding displacer rod. If none of these troubles is apparent, the displacer or torque tube is probably sized for a different set of service conditions. The information on the nameplate should be deleted or corrected for the new service and the unit recalibrated for the new service. Remember that with a standard displacer and torque tube on water service, the controller or transmitter is designed to give full output pressure change over the entire displacer length (except with a Type 2503 controller, which gives full output change over only about 25 to 40 percent of the displacer length).

STARTUP

Adjustment locations are shown in figure 3.

Type 2500 Controller

1. Set the PROPORTIONAL BAND control to the maximum desired setting, corrected according to page 11 of the "Pre-Startup Checks" section as necessary.

2. Adjust the RAISE LEVEL control to the desired control point.

3. Slowly open the upstream and downstream manual control valves in the pipeline and close the manual bypass valve if one is used.

4. If desired, adjust the proportional band to the narrowest setting that will maintain stable control.

5. To ensure that the optimum proportional band setting has been obtained, momentarily create a load upset. If cycling occurs, broaden the proportional band until process oscillations diminish rapidly. In general, the narrowest proportional band that will not produce cycling will provide the best control.

Type 2500T Transmitter

1. Make sure that the SPECIFIC GRAVITY and ZERO ADJUSTMENT controls are set correctly, according to the "Type 2500 Controller or 2500T Transmitter" portion of the "Pre-Startup Checks" section.

2. Slowly open the upstream and downstream manual control valves in the pipeline and close the manual bypass valve if one is used.

Type 2500S Controller

1. Set the switching points as desired, according to the "Type 2500S Controller" portion of the "Pre-Startup Checks" section.

2. Slowly open the upstream and downstream manual control valves in the pipeline and close the manual bypass valve if one is used.

3. If necessary to change switching points, do so as mentioned in step 1.

Type 2503 Controller

1. Set the switching points as desired, according to the "Type 2503 Controller" portion of the "Pre-Startup Checks" section.

2. Slowly open the upstream and downstream manual control valves in the pipeline and close the manual bypass valve if one is used.

3. If necessary to reposition switching points, do so by adjusting the RAISE LEVEL control as desired. For example, if the differential gap is set for 4 inches of level change, this 4 inches can be set anywhere within the length of the displacer. When setting the gap, be careful not to set it so that one end is off the displacer.

PRINCIPLE OF OPERATION

All 2500 and 2503 Series controller/transmitters use the same basic pressure-balanced relay with a yoked double-diaphragm assembly. The following descriptions show how the relay works in conjunction with the various controller/transmitter constructions.

Type 2500 Controller or 2500T Transmitter

The relay connection has a fixed restriction through which supply pressure must bleed before it can enter the inner bourdon tube channel (figure 13). A steady-state process variable (for instance, constant vessel level) holds the torque tube and attached flapper steady in relation to the nozzle. This allows pressure to escape between the nozzle and flapper at the same rate it bleeds into the bourdon tube. Nozzle pressure also registers on the large diaphragm, and output pressure on the small diaphragm. Since the area ratio of these diaphragms is three to one, a 12 psig change in output pressure need be balanced by only a 4 psig change in nozzle pressure.

A process variable change either raises or lowers the displacer and moves the flapper with respect to the nozzle. An increasing variable with direct action, or decreasing variable with reverse action, produces a nozzle-flapper restriction that increases the loading on the large diaphragm and opens the relay valve to additional supply pressure. But a decreasing variable with direct action, or increasing variable with reverse action, produces a nozzle-flapper opening that bleeds off pressure on the large diaphragm and opens the relay valve to exhaust output pressure.

The three-way proportional valve can be opened and adjusted to allow some or all of the output pressure change to feed back to the outer bourdon tube channel in order to change the proportional band of the controller. The bourdon tube flexes in the same direction that the flapper is moving, counteracting the pressure change in the nozzle and again equalizing the relay diaphragm pressure differential. The relay valve maintains a new output pressure according to the change in sensed displacer position.

A wide-open proportional valve permits feedback of all the output change and produces 100 per cent proportional response. Closing of this valve produces smaller proportional responses, since part of the output change is vented through the valve exhaust and only the remainder is available to reposition the bourdon tube.

Figure 13 illustrates these principles at work in a direct-acting right-hand-mounted construction controlling liquid inflow to a vessel, by means of a direct-acting diaphragm-actuated control valve. Bourdon tube positions would be reversed for direct action with left-hand mounting or reverse action with right-hand mounting.

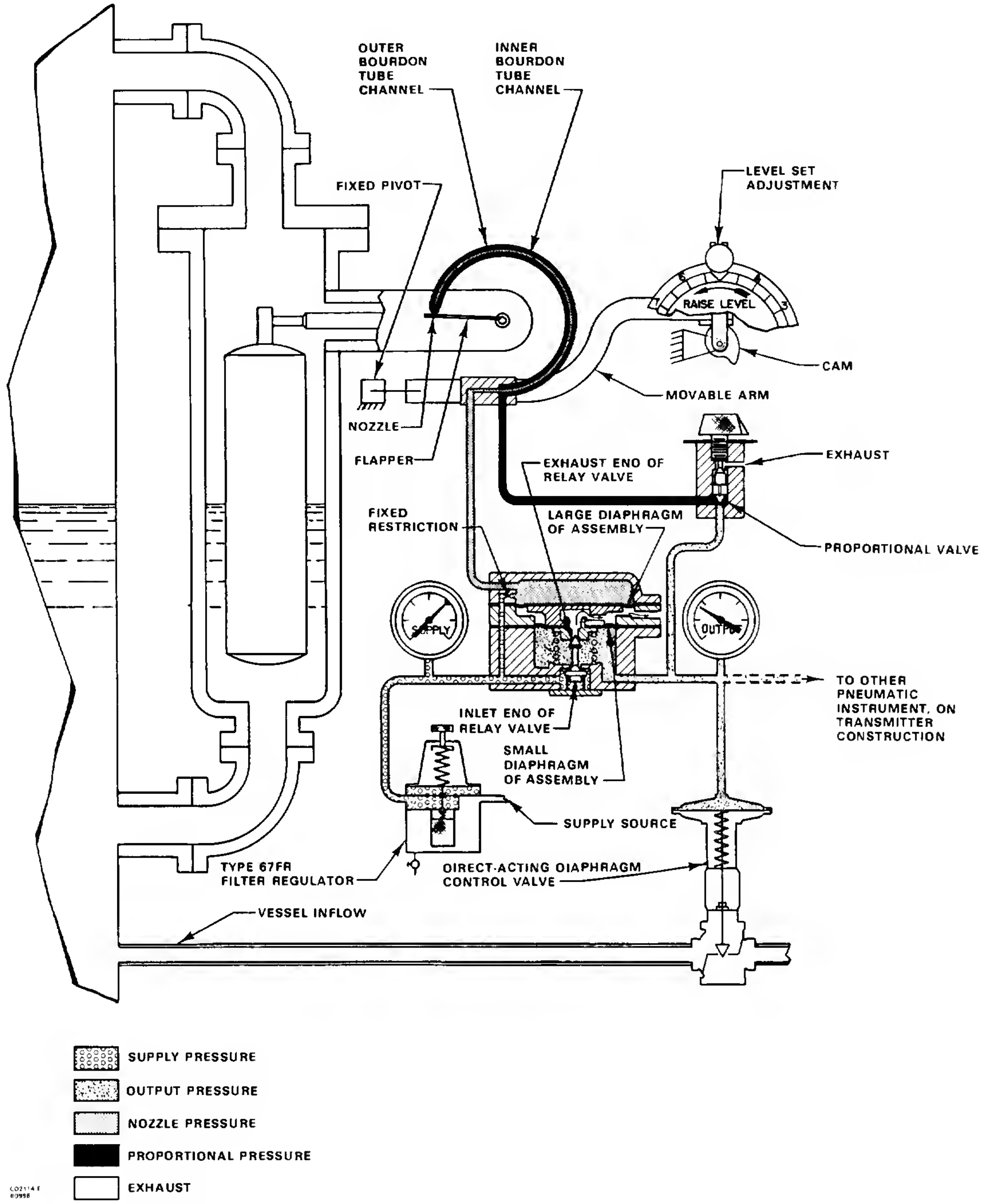


Figure 13. Direct-Acting, Right-Hand-Mounted 2500-249/259B Series Controller/Transmitter

Type 2500S Controller

This construction has the same flapper, relay and proportional valve as does the Type 2500 controller. However, the bourdon tube is connected (figure 3) so that output pressure change feedback twists the nozzle opposite the way the flapper is moving. This completely opens the relay valve either to full supply pressure or to full exhaust of the loading pressure, allowing no in-between throttling.

Type 2503 Controller

As long as the process variable remains above the lower snapping point on a direct-acting controller (or below the upper snapping point on a reverse-acting controller), the

flapper remains far enough away to keep the bourdon tube valve closed and prevent any pressure escape from the bourdon tube. The relay valve closes at the exhaust end, opens at the inlet end, and supply pressure is transmitted to the control device.

When the process sufficiently decreases with direct or increases with reverse action, the flapper pushes the bourdon tube valve in enough to seal the inner bourdon tube channel (figure 14). This opens the outer channel and permits full exhaust of loading pressure from the control device, initiating appropriate control action. The control action continues until the level or density change again moves the flapper away enough to permit closing of the bourdon tube valve and full application of supply pressure to the control device.

Figure 14 illustrates these principles at work in a reverse-acting right-hand-mounted construction. Bourdon tube positions would be reversed for direct action with right-hand mounting or reverse action with left-hand mounting.

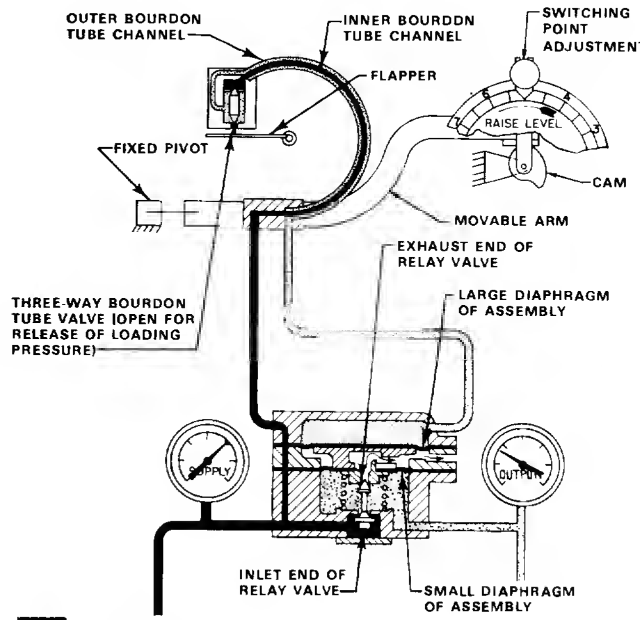


Figure 14. Reverse-Acting Type 2503R Controller

MAINTENANCE

The 2500 and 2503 Series controllers/transmitters are used in combination with 249 Series and Type 259B displacer type sensors.

WARNING

Personal injury or property damage due to sudden release of pressure, contact with hazardous fluid, fire, or explosion can be caused by puncturing, heating, or repairing a displacer that is retaining process pressure or fluid. This danger may not be readily apparent when disassembling the sensor or removing the displacer. Before disassembling the sensor or removing the displacer, observe the more specific warning provided in the sensor instruction manual.

Troubleshooting

Each numbered heading indicates a major fault, and each lettered entry below the fault lists a possible cause for that fault and various suggestions for correcting it. Some causes and corrections may be invalid if the alphabetical and numerical order is not followed as given. When trouble-shooting, open loop conditions must exist unless other-wise stated. One way to obtain an open loop is to ensure that there is no flow through the final control element. Another way to obtain an open loop is to disconnect the controller/transmitter output signal line and plug the output connection.

When monitoring the process variable, use the most accurate level indicating device readily available. The output signal measuring device should have a corres-ponding accuracy. There is no advantage in using an output signal measuring device that has an accuracy greater than that of the level indicating device.

Type 2500, 2500S, or 2503 Controller

1. Process wanders or cycles around set point (Type 2500 controller only)

a. Check that all controls have been set according to the appropriate "Pre-Startup Checks" procedure on pages 10 through 13.

b. Check for an offset or fluctuating supply pressure by making sure that the supply pressure regulator is set correctly and functioning properly, and that this controller is the only instrument being supplied by the regulator. If the supply regulator cannot be set properly, clean, repair, or replace it as necessary.

c. Check cage, vessel, or stillwell installation to make sure that the displacer and displacer rod are hanging freely. If mounting is not the problem, check for a leaky displacer or other damaged or worn sensor parts.

d. Check for a malfunctioning relay by performing the "Testing Relay Dead Band" procedure on page 24.

2. Controller controlling off set point or switching points

a. Make sure that the supply regulator is set correctly and functioning properly. If the regulator cannot be set properly, clean, repair, or replace it as necessary.

b. Check for leaking or damaged controller feedback parts by pressurizing the system to 20 or 35 psig and checking with a soap solution around all O-rings, gaskets, tubing, and pressure connections. Repair or replace controller parts as necessary according to an appropriate following "Maintenance" procedure, paying special attention to the bourdon tube.

c. Correct a loose or misaligned flapper by centering it over the nozzle or bourdon tube valve, and securing it on the torque tube shaft. Then check for sensor damage by varying the process and seeing if the displacer and torque tube shaft respond appropriately.

d. Check whether process variables have changed. If they have, and they cannot be returned to the conditions for which the unit originally was calibrated, recalibrate according to the new process conditions.

3. Controller cannot attain full output range

a. Make sure that the supply regulator is set correctly and functioning properly, and that this controller is the only instrument being supplied by the regulator. Then vary the supply pressure and see if the SUPPLY and OUTPUT gauges respond properly. Replace gauges as necessary.

b. Correct a loose or misaligned flapper by centering it over the nozzle or bourdon tube valve, and securing it on the torque tube shaft. Then check for sensor damage by varying the process and seeing if the displacer and torque tube shaft respond appropriately.

c. Check whether process variables have changed. If they have, and they cannot be returned to the conditions for which the unit originally was calibrated, recalibrate according to the new process conditions.

d. Check for leaking or damaged controller feedback parts by pressurizing the system to 20 or 35 psig and checking with a soap solution around all O-rings, gaskets, tubing, and pressure connections. Repair or replace controller parts as necessary according to an appropriate following "Maintenance" procedure, paying special attention to the bourdon tube.

e. Depress the core assembly plunger (key 89, figure 19) to clean out the fixed restriction. Clean the screened vent in the bottom of the controller/transmitter case if this vent has become clogged. Then check for other clogged passages or a malfunctioning relay by changing the RAISE LEVEL setting until the flapper completely caps the nozzle, and seeing if output pressure builds rapidly to the supply pressure setting. (If this does not happen and the outlet end of the fixed restriction on a Type 2500 or 2500S controller needs complete cleaning, the orifice assembly may have to be removed according to the "Disassembling Relay" section on page 25). If this check is satisfactory, decrease supply pressure to 3 psig while observing output pressure. The nozzle or other air passages probably are clogged or frozen if output pressure drops to zero as supply pressure decreases. However, if output pressure drops to a value above zero and remains there, or if output pressure does not respond as described in the flapper cap check, repair or replace the relay as necessary.

4. Controller remains at full output only

a. Check that the SUPPLY gauge is registering supply pressure properly. If not, replace the gauge.

b. Perform previous check 3a.

5. Controller remains at either zero or full output

a. Perform previous check 3a.

b. Correct a loose or misaligned flapper by centering it over the nozzle or bourdon tube valve, and securing it on the torque tube shaft. Then check for sensor damage by varying the process and seeing if the displacer and torque tube shaft respond appropriately.

c. Perform previous check 3e.

Type 2500T Transmitter

1. Transmitter remains at full output only

a. Check that the SUPPLY gauge is registering supply pressure properly. If not, replace the gauge.

b. Perform previous check 3a.

2. Transmitter remains at either zero or full output

a. Perform previous check 3a.

b. Correct a loose or misaligned flapper by centering it over the nozzle or bourdon tube valve, and securing it on the torque tube shaft. Then check for sensor damage by varying the process and seeing if the displacer and torque tube shaft respond appropriately.

c. Perform previous check 3e.

3. Output out of tolerance after calibration.

a. Check whether process variables have changed. If they have, and they cannot be returned to the conditions for which the unit originally was calibrated, recalibrate according to the new process conditions.

b. Check cage, vessel, or stillwell installation to make sure that the displacer and displacer rod are hanging freely. If mounting is not the problem, check for a leaky displacer or other damaged or worn sensor parts.

c. Check for leaking or damaged transmitter feedback parts by pressurizing the system to 20 or 35 psig and checking with a soap solution around all O-rings, gaskets, tubing, and pressure connections. Repair or replace transmitter parts as necessary according to an appropriate following "Maintenance" procedure, paying special attention to the bourdon tube.

d. Check for clogged or frozen air passages, especially in the SPECIFIC GRAVITY control proportional valve, if there is a change from the original calibration when the process has not changed. Clean or replace the proportional valve as necessary.

e. Check for an offset or fluctuating supply pressure by making sure that the supply regulator is set correctly and functioning properly, and that this transmitter is the only instrument being supplied by the regulator. If the supply regulator cannot be set properly, clean, repair, or replace it as necessary.

f. Check for a malfunctioning relay by performing the "Testing Relay Dead Band" procedure on page 24.

Removing Controller/Transmitter from Sensor

WARNING

To avoid injury in the following steps, turn off the supply pressure and carefully release any pressure trapped in the controller or transmitter before breaking any pressure connection. Bypass the control device if continuous operation is required during maintenance.

1. Disconnect the supply and output pressure tubing from the controller or transmitter. On a controller/transmitter with indicator, remove the pointer assembly according to step 1 of the "Replacing Bourdon Tube" section on page 23.

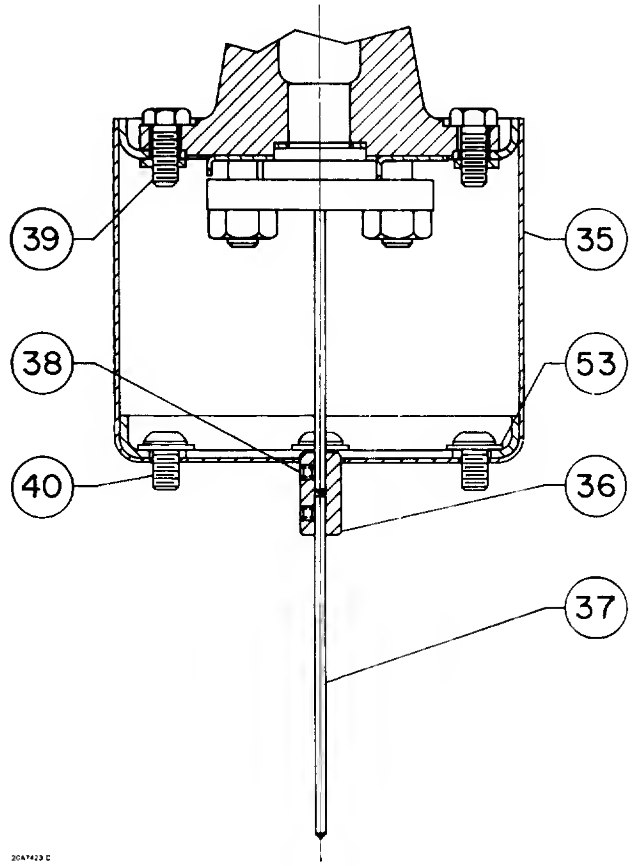


Figure 15. Heat Insulator

2. Loosen the top hex clamp nut (key 40, figure 17 or 18) and remove the flapper base (key 30, figure 17 or 18) from the torque tube rotary shaft.

CAUTION

If the hex clamp nut has not been loosened or the pointer removed according to step 2, attempting to remove the controller or transmitter from the sensor may bend the flapper or rotary shaft. Be careful that the back of the controller/transmitter case or the heat insulator does not drop down and bend the rotary shaft or shaft extension.

3. Remove any insulating tape from the joint between the controller/transmitter case and the torque tube arm. Remove the four cap screws (key 39, figure 15) that hold the controller/transmitter or heat insulator to the torque tube arm. Pull the case straight out from the torque tube arm, easing it over the shaft coupling (key 36, figure 15) if one is installed.

Note

Perform the following step only if it is necessary to remove a heat insulator from the controller/transmitter case. Key numbers in this step are shown in figure 15.

4. Use a 3/16-inch hex (Allen) wrench to remove the button head cap screws (key 40). Remove four washers (key 53) and the insulator assembly (key 35).

Changing Mounting Methods

WARNING

To avoid injury from contact with the process liquid, lower the vessel level below the torque-tube arm before proceeding. Be careful to avoid overloading a thin-wall torque tube and/or overweight displacer. For closed vessels, release any pressure that may be above the liquid.

1. Remove the controller or transmitter as described previously.

2. A controller or transmitter is attached to the sensor in one or the other of the mounting positions shown in figure 4: right hand (with the case to the right of the displacer when looking at the front of the case) or left hand (with the case to the left of the displacer). Remove the torque tube arm from the sensor or vessel according to the appropriate 249 Series and/or Type 259B instruction manual. Reinstall the torque tube in the opposite position.

3. Check the desired control action to determine if it also is necessary to reverse the controller/transmitter action. The bourdon tube should be mounted in the proper position as shown in figure 16.

4. Remove the RAISE LEVEL dial from a controller, turn it over, and install it in the desired position. The arrow on it under the word FLOAT should point toward the displacer.

5. On a controller/transmitter with indicator assembly, remove two screws (key 41, figure 17), turn the front plate (key 54, figure 17) to the side that will have the FLOAT arrow pointing toward the displacer, and secure the plate with the screws.

6. Install the controller or transmitter according to the next section.

Mating Controller/Transmitter to Sensor

Note

If the installation is in a location that is not readily accessible and shop calibration is required, remove the torque tube arm from the cage or vessel before mating the controller or transmitter to the sensor. Install the controller/transmitter on the torque tube arm in the shop; then calibrate and return the controller/transmitter and torque tube arm assembly to the installation.

Note

Perform step 1 only if adding a heat insulator to a unit that does not have one. Key numbers in this step are shown in figure 15.

1. Secure the shaft extension (key 37) to the torque tube assembly rotary shaft with the shaft coupling (key 36). Tighten both set screws (key 38), with the coupling centered as shown in the figure. Then mount the insulator assembly (key 35) on the controller/transmitter case with four washers (key 53) and button-head cap screws (key 40). Tighten the screws with a 3/16-inch hex (Allen) wrench.

CAUTION

In the following step, avoid bending the rotary shaft of the torque tube assembly. Bending or side loading of this shaft could cause erroneous readings.

2. Carefully slide the controller/transmitter case straight in, easing the attached heat insulator over the shaft coupling (key 36, figure 15) if necessary. Secure the case or insulator to the torque arm with the four cap screws (key 29, figure 15).

Note

If a heat insulator is used, do not insulate its exterior.

3. On a unit without a heat insulator, tape the joint between the case and torque tube arm to minimize the entrance of atmospheric moisture around the torque tube rotary shaft.

4. Install the flapper base (key 30, figure 17 or 18) on the torque tube rotary shaft, making sure the flapper is centered

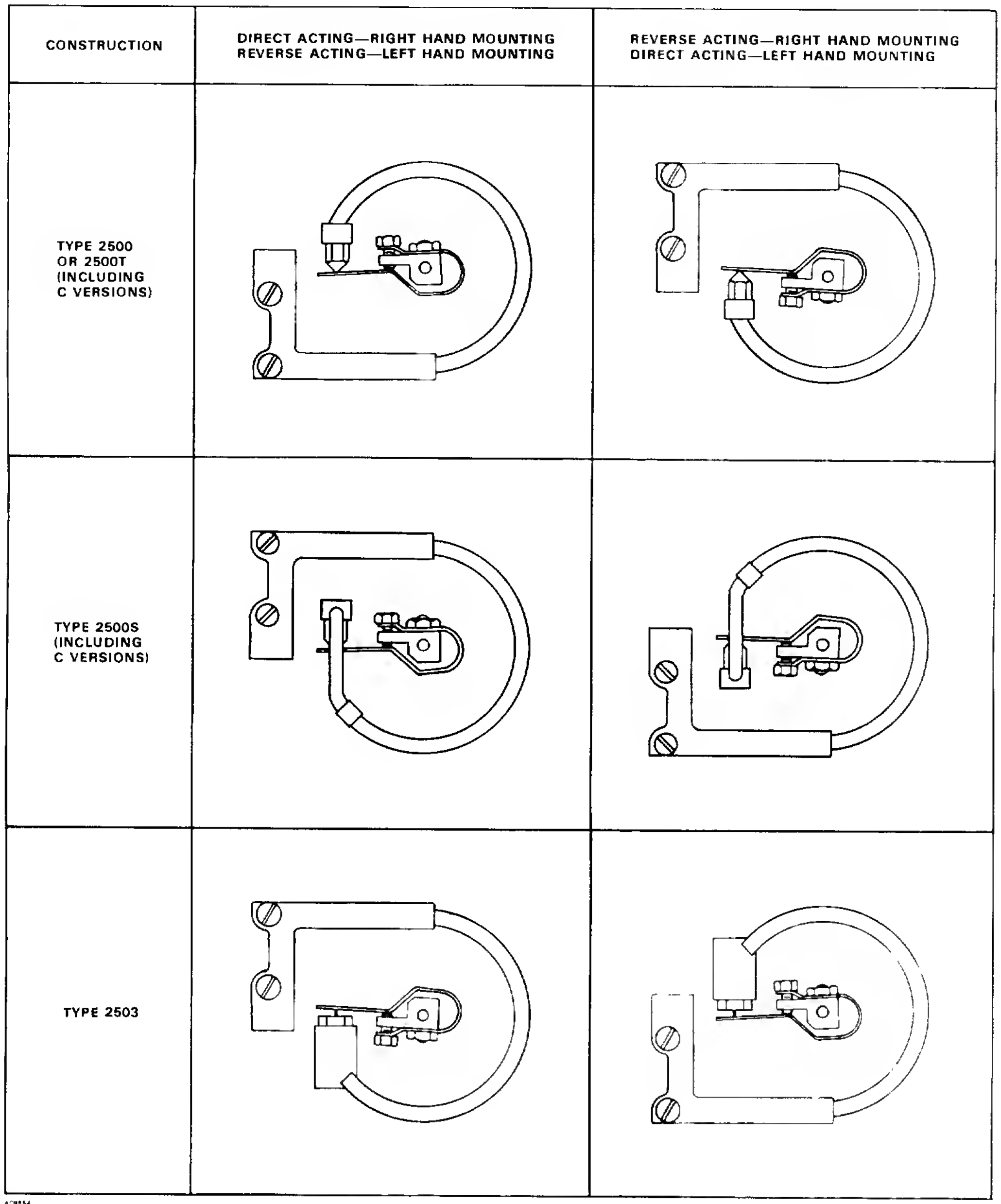


Figure 16. Bourdon Tube-Flapper Arrangements for Various Actions and Mountings

over the nozzle or bourdon tube valve. Secure the base with the top hex clamp nut (key 40, figure 17 or 18). On a controller/transmitter with indicator, install the pointer assembly according to the "Replacing Bourdon Tube" section.

5. Connect the supply and output pressure tubing. Perform the "Calibrating Procedure" on page 15 and any other necessary part of the "Calibration" sequence.

Replacing Bourdon Tube

Key numbers are shown in figure 17 or 18.

1. Disconnect the tubing (keys 10 and 11) from the bourdon tube base. On a controller or transmitter with indicator assembly, loosen the side hex clamp nut (key 40) and remove the pointer assembly (key 51) from the torque tube rotary shaft.

2. Remove the mounting screws (key 45) and bourdon tube assembly (key 16).

3. Inspect the bourdon tube and replace if necessary, using a tube with black color code for a 3 to 15 or 0 to 20 psig range or a tube with red color code for a 6 to 30 or 0 to 35 psig range. The correct range is stamped at the tube base.

4. Mount the bourdon tube on the level set arm (key 28) and secure with the mounting screws, using the proper orientation as shown in figure 16. Connect the tubing to the tube base, with tubing from the R connection on the relay (key 34) going to the marked base connection. The other tubing goes to the unmarked base connection. With an indicator assembly, install the pointer assembly on the rotary shaft and tighten the hex nut.

5. Perform the "Calibrating Procedure" on page 15 and any other necessary part of the "Calibration" sequence.

Reversing Action

Note

The following procedure will be necessary to restore previous action if the mounting method has been changed. Key numbers are shown in figure 17 or 18.

1. Reposition the bourdon tube (and indicator assembly if used) according to steps 1 through 4 of the "Replacing Bourdon Tube" section.

2. Loosen the top hex clamp nut (key 40) and remove the flapper base (key 30) from the torque tube rotary shaft. Turn the flapper base over and install it on the rotary shaft, using the proper orientation as shown in figure 16 and making sure the flapper is centered over the nozzle or bourdon tube valve.

3. Perform the "Calibrating Procedure" on page 15 and any other necessary part of the "Calibration" sequence.

Changing Proportional Valve

Note

The following procedure may also be used in converting to or from any type number in this manual.

1. Unscrew the base of the PROPORTIONAL BAND or SPECIFIC GRAVITY adjustment assembly (key 36 or 90, figure 17), or the 1/8-inch NPT pipe plug (key 73, figure 18), from the relay base (key 23, figure 17 or 18).

2. Install the pipe plug or the desired adjustment assembly into the relay base.

Testing Relay Dead Band (Type 2500 Controller or 2500T Transmitter Only)

1. Replace the appropriate adjustment assembly with the 1/8-inch NPT pipe plug according to the "Changing Proportional Valve" section.

2. Turn on the supply pressure and set it to 20 or 35 psig.

3. By changing the process variable and adjusting the RAISE LEVEL or ZERO ADJUSTMENT control, set the output pressure to 15 or 30 psig. While monitoring the output pressure, slowly change the process until an output pressure change can just be detected, and record the value of the process variable at the detection point.

4. Change the process variable in the opposite direction until another output pressure change can be detected, and again record the value of the process variable. If the difference between the two recorded values (the dead band) is more than 0.2% of the maximum displacer length, the relay will have to be replaced or repaired according to the "Changing Relay" and "Disassembly Relay" sections that follow.

5. Turn off the supply pressure, remove the pipe plug, and install the appropriate adjustment assembly.

Changing Relay

The relay may be removed for cleaning or repair.

1. On a controller or transmitter with indicator assembly, loosen the two lower screws (key 96, figure 19) of the relay case and slide out the indicator base plate (key 53, figure 17).

2. Disconnect the tubing (key 11, figure 17, or keys 10 and 11, figure 18) from the relay.

3. Remove both mounting screws, the relay, and the relay gasket (keys 43, 34, and 22, figure 17 or 18).

4. Install a new gasket, the replacement relay, and both mounting screws. Reconnect the tubing. On a controller or transmitter with indicator assembly, slide the base plate under the two lower screws of the relay case, align the plate so that the pointer will read properly, and tighten the screws.

Disassembling Relay

Disassembly can be accomplished in the following steps. Key numbers are shown in figure 19.

1. Remove the relay according to the "Changing Relay" section.

2. Remove the orifice assembly or connector (key 88) and check for plugging or damage. Replace the O-ring (key 90) before installing the orifice assembly.

3. Remove the casing screws (key 96) and washers (key 98), casing assembly (key 85), and top diaphragm (key 91). On a high-temperature relay also remove the top gasket (key 100) that covers the top diaphragm.

4. Remove the spacer ring (key 84), diaphragm assembly (key 86), and relay spring (key 92) from the relay body (key 83). On a high-temperature relay also remove the bottom gasket (key 99) from underneath the diaphragm assembly.

5. Remove the screws (key 97), spring plate (key 95), spring plate gasket (key 94), spring (key 93), and valve plug (key 87).

6. Inspect the diaphragms and gaskets and replace if necessary. Also replace the spring and valve plug if they show signs of corrosion. The lower diaphragm comes as part of an assembly and must be installed as such. Clean all parts thoroughly before assembling.

7. Put the valve plug and its spring in the relay body. Replace the spring plate gasket and spring plate and secure with four screws.

8. Place the relay spring in the relay body and, on a high-temperature relay, install a bottom gasket. Install the diaphragm assembly, spacer ring, and top diaphragm on the body so that all flow passage holes are lined up. On a high-temperature relay also install a gasket over the top diaphragm.

9. Put the casing assembly on the top diaphragm so that the lugs on the casing and spacer ring line up and are also lined up with the body lug.

10. Install the casing screws and tighten them evenly to ensure a good seal.

11. Install the assembled orifice assembly, and install the relay according to the "Changing Relay" section.

ORDERING INFORMATION

When corresponding with your Fisher representative about this equipment, always mention the serial number of the unit. The serial number can be found on the controller/transmitter-sensor nameplate. Pressure and temperature ratings, displacer size, material, and collapsing pressure are also stamped on this plate.

When ordering parts, also state the complete eleven-character part number of each part required, as shown in the following "Parts List".

PARTS LIST

Heat Insulator (figure 15)

Key	Description	Part Number
35	Heat Insulator Assembly, SST	22A0033 X012
36	Shaft Coupling, SST	1A5779 35032
37	Shaft Extension, K-Monel‡	1B6815 40022
38	Set Screw, SST (2 req'd)	1A5186 38992
39	Cap Screw, steel, pl (4 req'd)	1A3816 24052
40	Cap Screw, steel, Cd pl (4 req'd)	1V2395 28982
53	Washer, carbon steel, pl (4 req'd)	1B8659 28982

Controller/Transmitter† (figure 17 or 18)

Key	Description	Part Number
1	Pilot Case Back, zinc	4C895044012
2	Pilot Case Cover	
	Plastic	22A9197 X012
	Zinc	4C8951 44012
3	Door Handle, steel, Cd pl	1C8972 25082
4	Door Handle Shaft (not shown), brass	1C8984 14012
5	Machine Screw, steel	1C8958 28982
6	Spring Washer, SST	1C8970 36032
7	Door Hook, Steel, Cd pl	1C8971 25082
8	Stop Nut	
	Alum (plastic cover)	12A9194 X012
	Pl steel (zinc cover)	1C8959 28992
9	Roll Pin, SST (2 req'd) For plastic cover	1H2888 28992
9	Drive Pin, SST (2 req'd) For zinc cover	1C8991 X0022
10	Tubing Ass'y	
	All except Type 2503	
	Copper	1C9154 000B2
	SST	1N7983 X0012
	Type 2503	
	Copper	1H3093 17052
	SST	1H3093 X0012
11	Relay Tubing	
	Copper	1H2738 000A2
	SST	1N7984 X0012
12	Ball Bearing Ass'y Brass, Cd pl	1CB983 000A2
13	Retaining Ring, steel, Cd pl (2 req'd) For zinc cover	1A4658 28992
14	Gauge Glass (2 req'd) For zinc cover	0T0192 06042
15	Gauge Glass Gasket, neoprene (2 req'd) For zinc cover	0T0191 04082

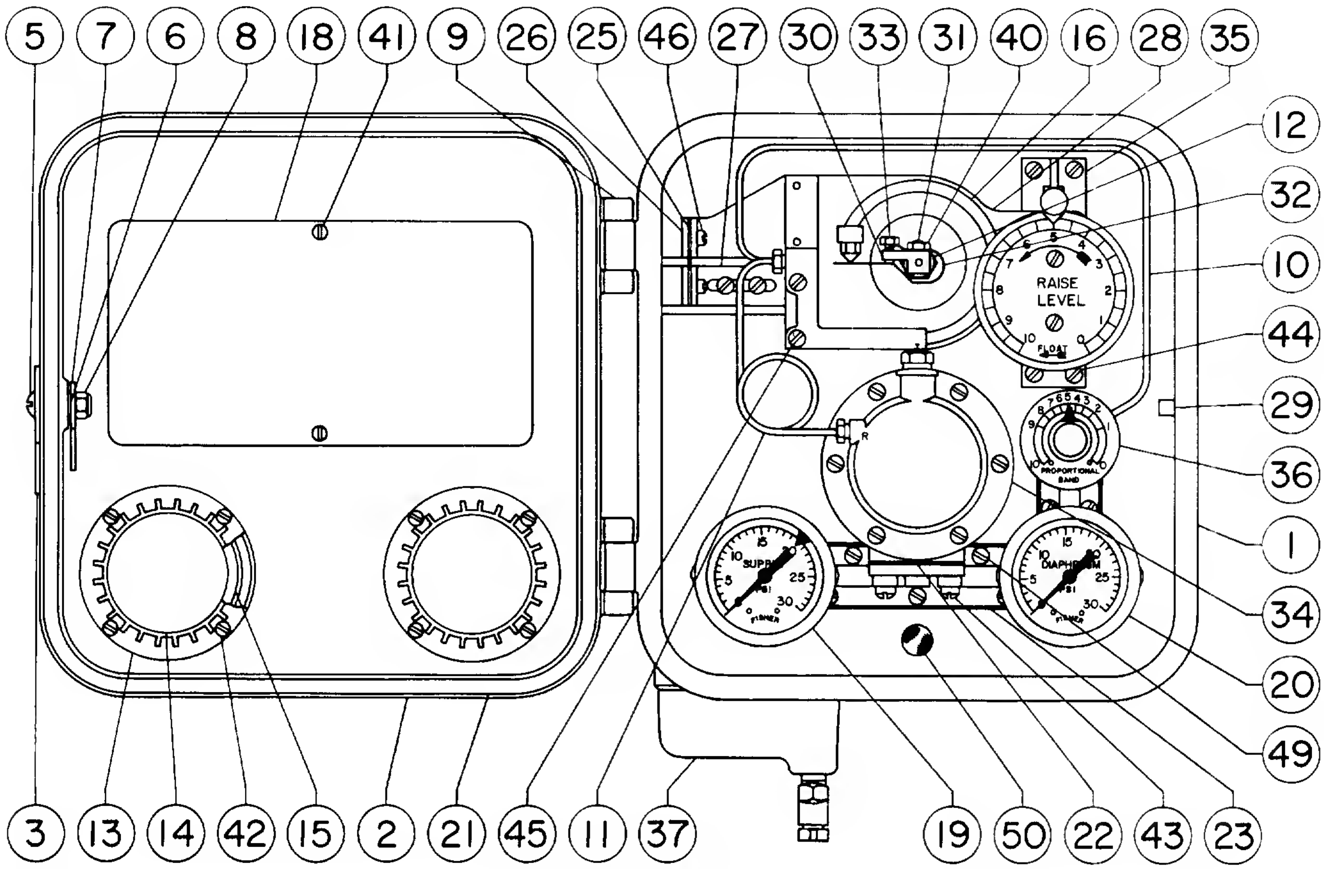
†The following parts also apply to constructions with R and/or C in the type number.
‡Trademark of International Nickel Co.

Key	Description	Part Number
16	Bourdon Tube Ass'y, bronze	
	Type 2500 and 2500T	
	3 to 15 psig	1C8981 000A2
	6 to 30 psig	1E5703 000A2
	Type 2500S	
	3 to 15 psig	1C9445 000A2
	6 to 30 psig	1J4319 000A2
	Type 2503	
	0 to 20 psig	1D1094 000A2
	0 to 35 psig	1H1449 000A2
18	Standard Instruction Plate	
	Types 2500 and 2500S, aluminum	1C9259 18992
	Types 2500T and 2503, brass	1C9903 18992
19	SUPPLY Gauge	
	3 to 15 psig range	12A5446 X012
	6 to 30 psig range	12A5448 X012
20	OUTPUT Gauge	
	3 to 15 psig range	12A5447 X012
	6 to 30 psig range	12A5449 X012
21*	Cover Gasket, nitrile	
	Zinc cover	1C9198 06432
22*	Relay Gasket	
	Standard, neoprene	1C8974 03012
	High-temperature, rubber	1N8738 04142
23	Relay Base, zinc	2C8952 44012
24*	Relay Base Gasket (not shown)	
	Standard, neoprene	1C8973 03012
	High-temperature, rubber	1N8739 04142
25	Flexure Strip, SST	1C8978 36012
26	Flexure Strip Nut, steel, Cd pl (2 req'd)	1C8975 25082
27	Flexure strip Base, steel, Cd pl	1C8977 25082
28	Level Set Arm, steel, Cd pl	1C8976 25082
29	DriveLok Pin, steel, pl	1C8989 28982
30	Flapper Base, brass, Cd pl	1C9261 14022
31	Shaft Clamp Screw, SST	184514 35172
32	Flapper, SST	1C9262 38992
33	Alignment Screw, brass, Cd pl	184517 14022
34	Pilot Relay (parts shown under separate heading)	
	All except 2503 Series controllers	
	Standard	10A9095 X0A2
	High-temperature	10A9096 X0A2
	2503 Series controllers	
	Standard	10A8941 X012
	High-temperature	10A8940 X012
35	Level Adjustment Ass'y (controllers only)	10A8939 X0A2
35	Zero Adjustment Ass'y (transmitters only)	10A8938 X0A2
36	PROPORTIONAL BAND Adjustment Ass'y (except transmitters and Type 2503 controllers	10A9122 X032
37	Type 67FR Regulator	. . .
38*	Filter Gasket (not shown)	
	Standard, neoprene	1C8986 03012
	High-temperature rubber	1N8740 04142
39	Cap Screw (not shown), steel, pl (2 req'd)	1C3988 24052
40	Hex Nut, steel, pl (2 req'd for C versions, 1 req'd for all others)	1A3303 28982
41	Screw, steel, pl (4 req'd for C versions, 2 req'd for all others)	1C9419 28982
42	Machine Screw, steel, pl (8 req'd) for zinc cover	1A5120 28982
43	Machine Screw, steel, pl (2 req'd)	1A3776 28992
44	Machine Screw, steel, pl (6 req'd)	1A5733 28982
45	Machine Screw, steel, pl (2 req'd)	1H1581 28992
46	Machine Screw, steel, pl (4 req'd)	1C8990 28982
47	Spring (not shown) SST	1J4234 37022
48	Cap Screw, steel, pl (4 req'd)	1A3816 24052
49	Machine Screw, steel, pl (13 req'd)	187839 28982
50	Screen, Monel‡	0L0783 43062
51	Pointer Ass'y (C versions only), SST/brass, Cd pl	1E8735 000A2
52	Washer (C versions only), steel (2 req'd)	1E8730 28992
53	Base Plate (C versions only), aluminum	1E8731 11992
54	Front Plate (C versions only), aluminum	1E8732 11992
73	Pipe Plug (Type 2503 only), brass	1A6219 14012
90	SPECIFIC GRAVITY Adjustment Ass'y (transmitters only)	10A8870 X0A2

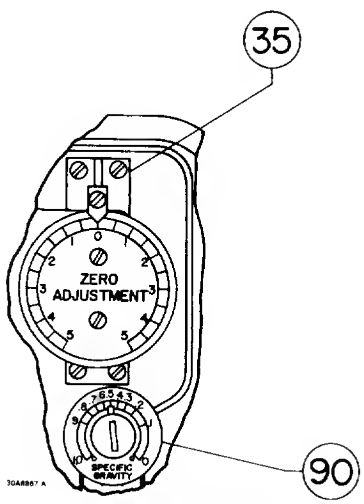
Relay (figure 19)

Key	Description	Part Number
83	Relay Body, zinc/brass	2H2693 00082
84	Spacer Ring, zinc	2K4404 44012
85	Casing Ass'y zinc/steel	1C9369 000A2
86*	Diaphragm Ass'y	
	Standard, nitrile	1C9370 000A2
	High-temperature, polyacrylate	1K6996 000A2
87	Valve Plug, brass	0Y0617 14012
88*	Orifice Ass'y (all except Type 2503), brass	1H8264 000A2
88	Connector (Type 2503 only), brass	1D1167 14022
89	Core Ass'y (all except Type 2503), SST	1E2303 000A2
90*	O-Ring	
	Standard & 2503, nitrile	1D6875 06992
	Hi-Temp, Viton	1N4304 06382
91*	Top Diaphragm	
	Standard, nitrile	1L5556 02042
	High-temperature, polyacrylate	1K6999 02272
92	Relay Spring, steel, Cd pl	1C8961 27012
93	Valve Spring, SST	0X0836 37022
94*	Spring Plate Gasket	
	Standard, neoprene	1H2696 03012
	High-temperature, rubber	1K7000 04142
95	Spring Plate, steel, Cd pl	1H2697 25072
96	Machine Screw, steel, pl (6 req'd)	1A3294 28992
97	Machine Screw, steel, pl (4 req'd)	1A3319 28982
98	Washer (standard only), steel, pl (6 req'd)	1P8261 28982
99*	Bottom Gasket (high-temperature only), rubber	1K7001 04142
100*	Top Gasket (high-temperature only), rubber	1K7002 04142

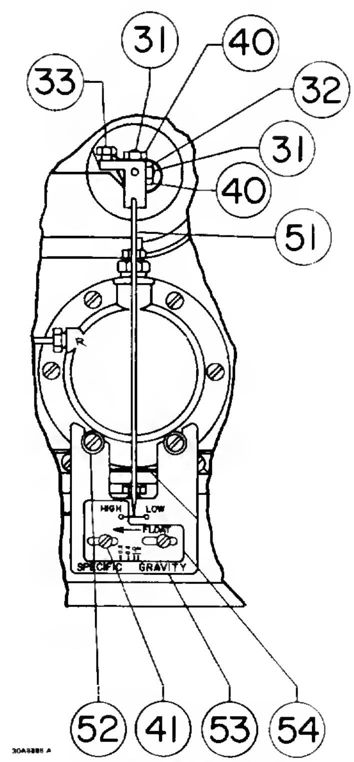
*Recommended spare part.
‡Trademark of International Nickel Co.



TYPICAL CONTROLLER



TRANSMITTER ADJUSTMENT DETAILS



DETAIL OF INDICATOR ASSEMBLY ON C VERSIONS

Figure 17. 2500 Series Controller/Transmitter Constructions

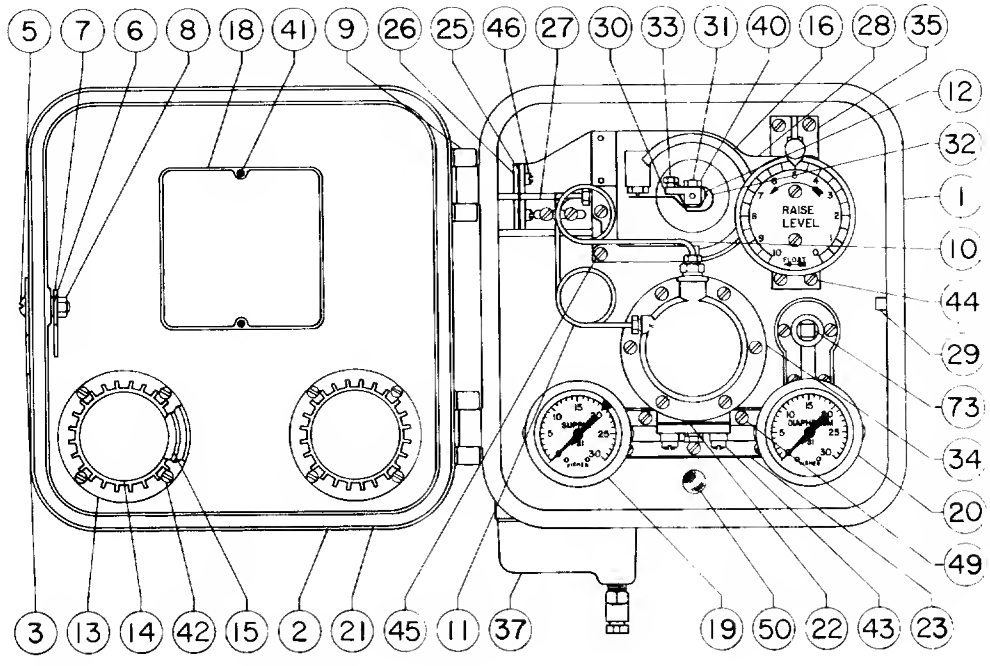
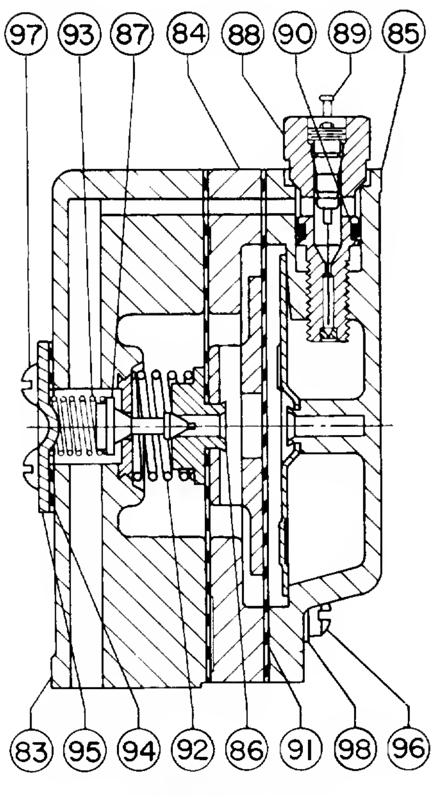
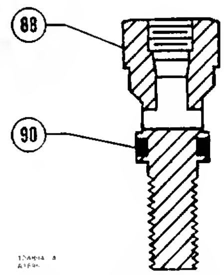


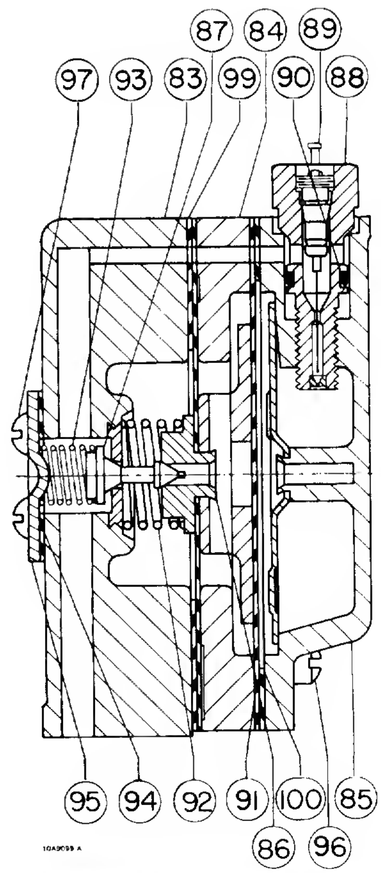
Figure 18. Type 2503R Controller Construction



STANDARD 2500 SERIES



TYPE 2503 CONNECTOR DETAIL



HIGH-TEMPERATURE 2500 SERIES

Figure 19. Relay Constructions